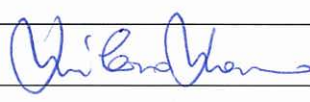
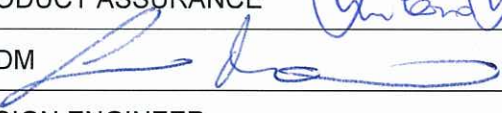
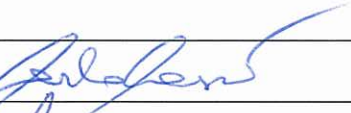


EXOMARS

PRODUCT ASSURANCE REQUIREMENTS FOR SUBCONTRACTORS

DRL/DRD: N/A
W.P. No: EB0-1ACA

<i>Written by</i>	<i>Responsibility</i>
M. MILAZZO	AUTHOR
<i>Verified by</i>	
G.BRIA BERTER	CHECKER 
<i>Approved by</i>	
M. MILAZZO	PRODUCT ASSURANCE 
M. SPASARO	CADM 
	DESIGN ENGINEER
C. CASSI	SYSTEM ENGINEERING MANAGER 
P. SANTORO	PROGRAM MANAGER 
<i>Documentation Manager</i>	
P. FISSORE	

The validations evidence are kept through the documentation management system

CHANGE RECORDS

ISSUE	DATE	§ CHANGE RECORDS	AUTHOR
01	16.07.2007	First issue for ITT preparation	Marco Milazzo
02	18.01.2008	Revised for B2 Including BCR RIDs BCR RIDs implementation: AP-CI-01 03 Modified para 4.4 AP-CI-01 04 Modified para 4.4 AP-PA-11 02 Add Para 4.16 AP-PA-14 01 Modified 5.4.9 e 5.4.10 Updated Table 5.3 1 Failure consequence severity categories Updated 5.4.2 (FMECA) AP-SA-03 01 Modified Para 6.2 BCR-SC-DHS-01 01 Modified affected para AP-PA-09 Modified 8.5.1 Modified 8.8 Para 8.5.2 deleted	Marco Milazzo
03	23.02.2010	Revised for I-PDR implantation and B2X closure : Printing error Para 7.1.2 - BC-PCB instead of EXO-PCB Page 57 BC-PCB instead of EXO-PCB Page 83 BC-PCB instead of EXO-PCB Para 4.11 Add DCL AS BUILT (add note) Para 4.8.1 Wrong reference to applicable DRL PA-9 instead PA-8 PARA 12.3 DELIVERY DAY OF EIDP 14 Instead of 15 EEE Para 4.7Alert System ADD PA-SY-320-reference add sentence- "CPPA and users, is responsible to maintain an Alert status list treacing applicability and corrective actions (if any) as requested in para 4.7" Para 7.4.8 Electrical and Qualification Model (EM/EQM) ADD[PA-SY-1060] [PA-SY-1270]Modified printing error From I-PDR: RID PA 27 AND 29 Para 5.3.1.2 single point failure RID PA 84 Para 7.4.8 Electrical and Qualification Model (EM/EQM) UPDATED RID PA 76 Para 7.3.2 Radiation radar hard UPDATED RID PA 79 Para7.3.2 Radiation hardness assurance add sentence ref table set maximum tolleration of transient hight	Marco Milazzo

		level Due to ESA PA Requirement updating rev3.3 Para all - Typo corrected (phase D included) Para all - ECSS-Q-60C now applicable Para 2.1.3 modified to identify additional standard Para 2.1.3 ECSS-Q-70-38A replacing former PSS document Para 2.1.3 ECSS-M-40B now applicable Para 12 Exchanged numbering of outputs PA-32 and 33 Para 2.1.3 Suppressed reference to standard ASTM and added "contamination deposition" Para 8.12 Req. PA-SY-1950 reference to deliverable PA-32 replaced by reference to PA-33 Para 2.1.3 Replaced former PSS document by updated ECSS-Q-70-38 Para 4.15, MIP/KIP MODIFIED Para 1.1, Details ECSS Tailoring and replace mission by Flight Segment Para 1.2, Deleted: B2/C/D/E1 and add all project phases Para 2.1 Used standard text for NR introduction Para 2.2.1 Use standard text for IR introduction Para 4.5 Req. PA-SY-240, reference to ECSS-Q-40B added Para 4.8 Delete PA-SY-330, PA-SY-360 Para 4.8 Req. PA-SY-340, change higher to cleaner and delete last word "requirements", changed ref doc.. Para 5.3 Dependability engineering - Added Dependability in title of paragraph Para 5.3.1.1 Deleted subpara. 1, modified subpara. 2 Para 5.3.1.2 SPF definition update (with addition of ECSS-Q-30-02 wording), Editorial in critical SPF definitions Para 5.3.2. 1 Failure Tolerance -Basic requirements - change order of bullets and delete SPF, removed "software error" , Add note to clarify failure tolerance based on design for minimum risk Para 5.3.2.2 Additional specific requirements section1: degraded to not a requirement, deleted ref. to triple redundancy Para 5.4.1 Functional Analysis (FA)- Req. PA-SY-560/570/580 deleted Para 5.4.1 Req. PA-SY-590 add EXM-MS-TNO-ESA-00005 (which is wrong); corrected in TNO-00017 Para 5.4.3 Hardware/Software Interaction Analysis (HSIA) PA-SY-620 modified requirement	
--	--	--	--

		Para 5.4.8 Part derating analysis Req. PA-SY-680 text from req. PA-SY-1320 added Para 5.4.11 Hazardous commands identification PA-SY-720 update categories and add link to DRD PA-19 Para 5.5 Inputs to Critical items list (CIL) PA-SY-730 SPF definition for CI list clarified Para 5.6 Dependability Testing PA-SY-740 modified to address applicability of Q-30 chapter 9 Para 5.7 Failure Propagation PA-SY-750, 760 Failure propagation requirement reworted and NOTE added Para 6. SAFETY 6.1 General PA-SY-770, 780 PA-SY-870 moved, added - CSG safety reqs references removed; added pointer to Launch site reqs, Removed Proton references Para 6.1 PA-SY-870 editorials Para 6.2 Safety Management and Planning PA-SY-890 Nuclear safety authority- editorials(Nuclear safety authority- Section updated, removed references to GEP, Lander) Para 6.3 Hazard Severity Categories PA-SY-960, 970 Updated safety severity categories table to be in line with Q-40, table added Para 6.3 PA-SY-980 revised Para 6.4 Hazard Analysis/Residual Hazards PA-SY-1000 - editorials Para 6.5 Safety engineering - editorials Para 7 EEE COMPONENTS Paragraphs completely updated Main Modification due to: 1) IPDR RIDs implementation for B2X closure ▪ RID AP-84 ▪ RID AP-61 ▪ RID AP-85 ▪ RID AP-76 ▪ RID AP-79 ▪ RID AP-80 ▪ RID AP-82 2) ESA environmental spec doc EXM-MS-RS-ESA-00013 ISS 4 DRAFT 0 Para 7.4.2 Radiation Hardness Assurance 3) ESA PA Requirement updating rev3.3 Para 7.1 Req. PA-SY-1040, reference to ECSS-Q-ST-60C added and quality level changed to Class 2 Para 7.2 Req. PA-SY-1090, Ref changed to ECSS-Q-ST-60, para. 5	
--	--	---	--

		Para 7.2.1 Req. PA-SY-1120, ESA participation in PCBs modified Para 7.3 7.4 Req. PA-SY-1140, reworded and link to ECSS-Q-ST-60C provided Para Req. PA-SY-1150 reworded to introduce the ExoMars PPL for parts selection and to address low temperature application and add [IR 6] Para 7.4.1.1 Req. PA-SY-1160 reworded to introduce reference to ECSS-Q-ST-60C Para 7.4.1 Req. PA-SY-1200 Para 7.4.1.1 Req. PA-SY-1210 Para 7.4.2.2 Req. PA-SY-1260/1270/1280/1300/1310, unit corrected to "MeV cm²/mg" Para 7.4.2.2 Req. PA-SY-1260/1270/1300, radiation level change to 60 MeV cm²/mg Para 7.4.2.2 Req. PA-SY-1270/1280, add link to DRD PA-11/24 Para 7.4.2.2 Req. PA-SY-1310, requirement for PAD added. Para 7.4.3 Req. PA-SY-1320/1330, and output PA-25 deleted and NOTE added that these requirements are covered by para. 5.6.8 Para 7.4.4 Req. PA-SY-1370, add EQSR Para 7.4.4 Req. PA-SY-1380 CPPA PAD submission responsibility Para 7.4.5 Req. PA-SY-1390, reworded to address CDR and EQSR. Reference to PAD deleted, covered by PA-SY-1340 Para 7.4.5 Req. 1390, reference changed to ECSS-Q-ST-60C Para 7.4.5 Req. PA-SY-1400/1410 deleted, covered by ECSS-Q-ST-60C Para 7.4.6 Req. PA-SY-1420, reworded to provide reference to ECSS-Q-ST-60 Para 7.4.7 Req. PA-SY-1430/1440/1460 reworded and PA-SY-1450 deleted. LAT requirements reworded to provide reference to ECSS-Q-ST-60C and to detail LAT for additional components, Para 7.3.1 Req. PA-SY-1490, change to grade 2 Para 7.4.6.1 Req. PA-SY-1520/1530 reworded, PA-SY-1540 deleted. Requirements re-worded/deleted to provide reference to ECSS-Q-ST-60C and detail PRECAP for additional components. Para 7.4.6.4/7.4.5 Req. PA-SY-1550/1560/1570, reference changed to ECSS-Q-ST-60 Para 7.5.1 Req. PA-SY-1620 modified to provide reference to ECSS-Q-ST-60V Para 8.2 Req. PA-SY-1650 and Output PA-45, RFA added in the requirement and as DRD Para 8.2.1 Req. PA-SY-1690 reworded with the text and DRD PA-30. DRD deleted and output PA-30 replaced by Progress Report Para 8.3/8.3.1 Req. PA-SY-1700/1710, Output added to 1700, text	
--	--	--	--

		of deleted requirement 1710. Para 8.4 Req. PA-SY-1720 reworded to cover DRD PA-31, Output PA-31 deleted. Para 8.5 Req. Req. PA-SY-1740/1750, Output added to 1740, text of deleted requirement 1750. Para. 8.6, Title changed, PA-SY-1760, assessment replaced by control Output PA-33, deletion of DRD PA-33 Para 8.7 Req. PA-SY-1770/1780/1790 deleted Para 8.7 Req. PA-SY-1800, reference to DRD PA-27/28/29/30 deleted and Output P-32 moved below req. PA-SY-1800 Para 8.8 Req. PA-SY-1850 deleted, text used as Output for req. PA-SY-1840 Para 8.12/8.13/8.15 Req. PA-SY-1930, -1950, -1970, -1990, -2010, -2090, -2110 deleted, related text used as Output for the requirement before. Para 8.15 Req. PA-SY-2000 reworded to cover material combinations and to deleted permanent Para 8.18 PA-36 Deleted Para 8.17 Req. PA-SY-2050., reworded to provide link to CIL, Output PA-35 deleted, covered by PA-3 Para Add [NR 097], Relifing Procedure - EEE Components Para 11 Modified Para 12 UPDATED PA DRL (22)	
04	15.05.2010	Revised for ESA PA Requirement iss 04 alignment. Modification due to ESA PA Requirement updating rev3.4 dated 12.03.2010 First Delivery for internal review (D-Delivery) Update to reflect updated Exomars mission concept and specify applicability of updated ECSS documents. Para 1.1 Text modified to reflect multiple elements of the Exomars project .. Para 2.1.3 Replacement of old issues with newer versions NR A43 DELETE NR A44 DELETED NR A45 DELETED NR A46 DELETED NR A18 NEW ECSS ISSUE NR A19 NEW ECSS ISSUE NR A20 NEW ECSS ISSUE NR A21 NEW ECSS ISSUE NR A23 NEW ECSS ISSUE NR A24 NEW ECSS ISSUE NR A25 NEW ECSS ISSUE NR A98 NEW ECSS ISSUE NR A26 NEW ECSS ISSUE NR A27 NEW ECSS ISSUE NR A28 NEW ECSS ISSUE NR A29 NEW ECSS ISSUE	Marco Milazzo

		NR A30 DELETED NR A31 NEW ECSS ISSUE NR A32 NEW ECSS ISSUE NR A33 NEW ECSS ISSUE NR A34 DELETED NR A35 DELETED NR A35 DELETED NR A36 NEW ECSS ISSUE NR A37 NEW ECSS ISSUE NR A38 NEW ECSS ISSUE NR A39 NEW ECSS ISSUE NR A99 NEW ECSS ISSUE NR A100 NEW ECSS ISSUE NR A97 NEW ECSS ISSUE Addition of new doc: Para 2.2.3 [NR TBD]ECSS-Q-ST-70-31C Application of Paints and Coating on Space Hardware Para 2.2.3 [IRA 94] Document reference corrected (now 0016). Para 8.7 Vacuum Rewording of PA-SY-1840 due to updated NR A18 ECSS-Q-ST-70-02C Thermal vacuum outgassing test for the screening of space materials Modification due to ESA PA Requirement updating rev3.5 dated 15.03.2010 P version update for Project CCB review Change log References to page numbers in changelog deleted Issue/revision number of D Delivery modified from 4/draft to 3/4 Para 5.6 Replacement of Segment with Elements Para 1.1Clarifications of GSE compliance Modification due to ESA PA Requirement updating rev3.6 dated 22.03.2010 A version for Project CCB #42 Discussion Para 2.2.3 Rover requirements Document added(EXM-RM-RS-ESA-00001) Para 2.2.3 [IR 015] ESA (document requirement description) DRD EXM-MS-RS-ESA-00010 Standard descriptive text for normative documents added Modification due to ESA PA Requirement updating rev 4/0 dated 24.03.2010 Version for CCB #43 Approved Scope modified to clarify applicability to Groundsegment Para 2.1 Added: [NR 128] JPL D-64939 Launch Service Requirement Document [NR 129] AFSCPSMAN 91-710 V3 Air Force Space Command Manual [NR 130] NASA-STD-8719.9 Standard for Lifting devices [NR 131] Transportation of radioactive material Deleted: [NR 01], [NR 03] and moved to Para 2.2 [IR] section Para 2.2 Added [IR116] Atlas Launcher User Manual [IR 01] Mission and System Requirements [IR 10] Rover Requirements	
--	--	---	--

		[IR 03] Management Requirement Document Para 3 Descriptive text of rewritten add sentences 5. DEPENDABILITY 5.3 Dependability engineering Para 5.3.1 added section on ExoMars Programme objectives (from MSRD_6.0 + PA Reqs_4.0) and allocation to the 2016 / 2018 mission Para 5.3.1.1 Table 5.3-1 updated including System/Module level severity categories Para 5.3.2.1 Reintroduced failure tolerance requirements description for System Level failure effects. Para 5.3.2.2 Added sentence which points to other system design requirements documents for possible additional specific requirements Para 5.3.3 PA-SY-550: added reference to Rover Requirements in addition to the already specified Mission & System Requirements 6. SAFETY 6.1 General PA-SY-840 Deleted 7. EEE SECTION 10.05.10 Para 7.1 reference to normative document updated. Reference to other paragraphs updated. Para 7.2.1 reference to PA-SY-1130 deleted. Para 7.2.2 reference to PA-SY-1100 changed to PA-SY-1130. Para 7.4.1 reference changed to new issue (ECSS-Q-ST-70-08C) Para 7.3 reference DCL format Para 7.4.1.1 reference to PA-SY-1200 deleted. Reference to normative document updated. Para 7.4.2.2 reference to PA-SY-1280 and PA-SY-1310 splitted. Multiple reference to PA-SY-1250 corrected. Reference to PA-SY-1300 moved in the paragraph to remove multiple reference. Para 7.4.4 multiple reference to PA-SY-1370 corrected. Reference to normative document updated. Para 7.4.6 reference to normative document updated. Para 7.4.6.1 reference to normative document updated. Para 7.4.6.2 reference to normative document updated. Para 7.4.6.3 reference to normative document updated. Para 7.4.6.4 reference to PA-SY-1580 deleted Para 7.4.7 reference to PA-SY-1430 and PA-SY-1440 corrected. Reference to normative document updated. Para 7.4.8 BC-PCB corrected in EXO-PCB Para 7.5.1 reference to PA-SY-1620 corrected. 8. Material and Processes Para 8.X ref. PA-SY-1810/1830/1870/1980/2030/2070/2120 modified for new ECCSS alignment Para 11.1.11 add paragraph "GSE Certifications (UE certification / USA certification)" PARA 12.1 DRL Updated (25) ADD TAS-I PA Requirements numbering (e.g. MS-PA-REQ-XXXX)	
--	--	---	--

05	21.01.2011	SPDR RIDs Implementation REF RID ACTION PDR-PAPP-AI-003 Para 2.1.2 EXM-MS-SSR-AI-0005 [NR 106] Cleanless contamination and control requirements iss 07 [NR0438] ExoMars RM Cleanliness and Contamination Control Requirements – EXM-RM-SSR-AI-0015 [NR0439] ExoMars RM Cleanliness and Contamination Control plan – EXM-RM-PLN-AI-0078 Para 11.1.11.1 TAS-I to update the PA requirements for sub-co's to include the information concerning CE marking as stated in TAS-I reply. from RID PA-PP-97 Change with correct references: a) Low Voltage Directive, 2006/95/EC (12.12.2006), b) EMC Directive, 2004/108/EC (15.12.2004) Para 7.4.2 MS-PA-REQ-3120 ELDR test method updated (S-PDR RID PA-PP-150). Para 7.4.2.2 MS-PA-REQ-31xx new requirement to address PA-SY-1270 (S-PDR RID PA-PP-150) Para 7.4.2.2 MS-PA-REQ-3170 reference to PA-SY-1270 removed (S-PDR RID PA-PP-150) Para 7.4.2.2 MS-PA-REQ-3170 and MS-PA-REQ-3180: text of MS-PA-REQ-3170 partially moved to MS-PA-REQ-3180 (editorial correction) Para 7.4.2.2 MS-PA-REQ-3180: typo corrected (error rate $1E(-11)\text{error}/(\text{bit}*\text{day})$) Para 7.4.2.2 MS-PA-REQ-3240 rewording according to S-PDR RID PA-PP-150. Approval of destructive-single-events sensitive components via RFD/RFW. Para 7.4.2.2 MS-PA-REQ-3230 rewording. Para 2.1.2 update of reference documents.	
----	------------	--	--

TABLE OF CONTENTS

1. INTRODUCTION	15
1.1 Scope.....	15
1.2 Applicability	15
2. DOCUMENTS.....	16
2.1 Normative Documents	16
2.1.1 Definition of Normative Documents	16
2.1.2 Thales Alenia Space Italia Normative Documents.....	16
2.1.3 ESA / NASA Normative Documents	16
2.2 Informative Documents	19
2.2.1 Definition of Informative Documents.....	19
2.2.2 Thales Alenia Space Italia Informative Documents	19
2.2.3 ESA / NASA Informative Documents.....	19
3. PRODUCT ASSURANCE REQUIREMENTS	21
3.1 Organisation and Management.....	21
3.2 PA progress reporting(Addition to ECSS-Q-00A para 3.5.3)	23
3.3 Product Assurance Plan.....	24
3.4 Product Assurance data file and databases(Addition to ECSS-Q-00).....	25
3.5 Subcontractors Suppliers PA Program	26
3.6 Right of Access, Participation	26
3.7 Approval Sequence	27
3.8 PA involvement in overall project documentation.....	27
3.9 Integration of lower data at higher level	27
3.10 Qualification Status Reporting.....	27
3.11 PA and Safety Plan (Addition to ECSS-Q-00A para 3.2).....	29
4. QUALITY ASSURANCE REQUIREMENTS	31
4.1 Quality Assurance Plan	31
4.1.1 Normative documents	32
4.1.2 QA Surveillance	32
4.2 Requirements.....	32

4.3	PA Programme Audits	32
4.3.1	Audits (Addition to ECSS-Q-20B para 4.6)	34
4.4	Critical Items Control	34
4.4.1	Critical Item definitions	35
4.5	Non-conformance Control System, RFW and Deviations	38
4.5.1	Failure analysis	40
4.6	Waivers	40
4.7	Alert System	40
4.7.1	Details about Alert / Problem notification see para. 7.3.9 of this document	41
4.8	Cleanliness and Contamination Control	41
4.8.1	Cleanless and contamination control Plan	43
4.9	Test Facilities	43
4.9.1	Test Performance Monitoring	44
4.10	Test Reports	44
4.11	End item Data package (EIDP)	44
4.12	Delivery review boards	46
4.13	Packaging, Marking and Labelling, Transportation	47
4.14	Handling, Storage, Preservation	47
4.15	Inspections (PA-SY-465)	48
4.16	Electrostatic Discharge Control	50
5.	DEPENDABILITY	51
5.1	Dependability Assurance	51
5.2	Dependability risk reduction and Control	52
5.3	Dependability engineering	52
5.3.1	Design criteria	53
5.3.1.1	Failure Consequence Severity Definition	55
5.3.1.2	Single Point Failure Definition	56
5.3.2	Failure Tolerance	58
5.3.2.1	Basic requirements	58
5.3.2.2	Additional specific requirements	59
5.3.3	Design approach	68
5.4	Dependability Analyses	68
5.4.1	Functional Analysis (FA)	69
5.4.2	Failure Modes, Effects and Criticality Analysis (FMECA)	69
5.4.3	Hardware/Software Interaction Analysis (HSIA)	70
5.4.4	Contingency Analysis	71
5.4.5	Common Mode and Common Cause Failure analyses	71

5.4.6	Reliability prediction	71
5.4.7	Worst Case Analysis	72
5.4.8	Part derating analysis.....	73
5.4.9	Maintainability Assessment.....	73
5.4.10	Availability analysis.....	74
5.4.11	Hazardous commands identification.....	74
5.5	Inputs to Critical items list (CIL)	75
5.6	Dependability Testing	75
5.7	Failure Propagation.....	75
6.	SAFETY	77
6.1	General	77
6.2	Safety Management and Planning	80
6.3	Hazard Severity Categories.....	82
6.4	Hazard Analysis/Residual Hazards.....	83
6.5	Safety engineering	85
6.6	Failure tolerance.....	88
6.7	Software	89
6.8	Product Liability Requirements	89
7.	EEE COMPONENTS	91
7.1	General	91
7.2	EEE Program management	92
7.2.1	Procurement policy	92
7.2.2	User tasks in EXO-PCB	93
7.3	Declared Component List.....	94
7.3.1	As built DCL	94
7.4	EEE Components Selection / Qualification	95
7.4.1	EEE components requirements on materials and processes.....	95
7.4.1.1	Prohibited materials and components	96
7.4.2	Radiation Hardness Assurance	97
7.4.2.1	Displacement damages and NIEL.....	102
7.4.2.2	SEE assurance.....	103
7.4.2.3	RADIATION REVIEW.....	106
7.4.3	Component Derating	108
7.4.4	EEE Components Approval	108
7.4.5	EEE component procurement specification	109
7.4.6	Quality Level	110
7.4.6.1	Additional tests	111
7.4.6.2	HYBRIDS.....	113

7.4.6.3	MMICs	113
7.4.6.4	ASIC/FPGA	113
7.4.6.5	In House Manufactured Parts.....	114
7.4.7	LAT/QCI	123
7.4.8	Long Lead Items	125
7.4.9	Alert / Problem notification	126
7.4.10	Attrition.....	126
7.4.11	Traceability	128
7.5	Quality Assurance & EEE Parts NCR	128
7.5.1	Manufacturer and part evaluation	128
7.5.1.1	Evaluation program	129
7.5.1.2	Radiation characterization.....	132
7.5.2	EEE NCR	132
7.5.3	Components in Off the shelf equipments.....	134
7.5.4	Use of Stock Components	134
7.5.5	EEE parts Documentation.....	135
7.5.5.1	Parts manufacturer's documentation requirements	136
7.5.6	Components Packaging, Handling and Storage.....	136
7.5.7	Shipment.....	138
7.5.7.1	Dispatch Documentation	139
7.5.8	Electrical and Qualification Model (EM/EQM).....	140
7.5.9	Ground Support Equipment	140
8.	MATERIALS, PROCESSES AND MECHANICAL PARTS (MPM).....	142
8.1	General	142
8.2	Declared Material/Parts and Process Lists.....	142
8.2.1	PMP Item number	143
8.3	Technical Requirements for the Selection of Materials	144
8.3.1	Deleted.....	144
8.4	Verification of curing conditions	144
8.5	Forbidden Materials	144
8.5.1	Use of radioactive and fluorocarbon materials	145
8.6	Bioburden control	146
8.7	Bioburden Reduction.....	146
8.8	Vacuum.....	147
8.9	Thermal Cycling.....	148
8.10	Environmental Interaction	148
8.11	Micrometeoroid/Debris Environment	149
8.12	Electrochemical Compatibility	149
8.13	Corrosion	150

8.14	Stress Corrosion	150
8.15	Fluid Compatibility	151
8.16	Allowable Stress.....	151
8.17	Limited Life Time.....	151
8.18	Processes.....	152
8.18.1	Process procedures.....	153
8.18.2	Processes for EEE mounting and assembly.	154
8.19	Printed Circuit Boards	154
8.20	Fasteners.....	154
9.	SW PRODUCT ASSURANCE	155
10.	QUALIFICATION STATUS REPORTING	156
10.1	Off-the-shelf (OTS) Equipment (DRD PA-42)	156
10.2	Qualification Status List (QSL)	158
11.	PA REQUIREMENT FOR GSE	160
11.1	PA Management.....	160
11.1.1	Reviews	160
11.1.2	Design and Manufacture.....	160
11.1.3	Documentation.....	161
11.1.4	GSE Dependability and Safety	162
11.1.5	General Requirements.....	166
11.1.6	FMECA	166
11.1.6.1	Criticality Categories	166
11.1.7	Critical Item	166
11.1.8	Safety.....	167
11.1.9	Materials	167
11.1.10	Cleanliness and PP	168
11.1.11	GSE Certifications (UE certification / USA certification).....	168
11.1.11.1	UE GSE Suppliers.....	168
11.1.11.2	USA GSE Suppliers	168
12.	DRL FOR PRODUCT ASSURANCE	169
12.1	HW/SW DRL PA DOCUMENTS (25).....	169
12.2	GSE DRL PA DOCUMENTS (25).....	172
12.3	Notification / Delivery Time Summary.....	173
12.4	Class acronyms	174

1. INTRODUCTION

1.1 Scope

This document defines the EXOMARS Product Assurance requirements for Subcontractors. The Flight elements, operation regime and associated GSE and associated HW-SW, shall be designed, manufactured, tested and operated in compliance with these requirements, which are applicable to subcontractors and their suppliers.

1.2 Applicability

The requirements are applicable to the all Flight elements (flight hardware, flight software and flight spares) Other hardware and software shall be safe for ground operations and shall be representative of flight hardware with respect to form, fit and function, and shall not lead to the failure or degradation of flight hardware/software.

The requirements defined here are applicable to all phases of the project up to the launch of the fully integrated and tested flight element. The P.A. program shall be implemented for all produced hardware and software, flight and ground.

The subcontractors and the suppliers shall implement the requirements of this document and prepare the required documentation at the level of assigned responsibility within the program (e.g. modules, subsystems, units, etc).

These requirements shall be made directly applicable to their suppliers.

These requirements are applicable as well to the EEE Components Procurement Agency (CPPA).

The subcontractors and the suppliers shall notify to TAS any requirements discrepancies.

This document contain a set of requirements to be verified by RoD,A,I,T (according to ECSS).

The verification method for each requirement shall be identified in the next issues of this document.

2. DOCUMENTS

TAS Normative and Informative References for ExoMars project are listed in document EXM-MS-LIS-AI-0001.

2.1 Normative Documents

2.1.1 Definition of Normative Documents

Normative References are directly applicable in their entirety to this document and are listed below as dated or undated references.

These normative references may be cited at appropriate places in the text.

For dated references, subsequent amendments to or revisions of any of these document apply to this list only when incorporated in it by amendment or revision.

For undated references, the latest signed version is applicable incorporated by the Contractor in the project baseline.

In case of conflict between this document and normative documents listed herein the Contractor shall inform the TAS Project Office for resolution.

2.1.2 Thales Alenia Space Italia Normative Documents

[NR 0105]	EXM-MS-SSR-AI-0014	EXOMARS Space Environment and Requirements Specification
[NR 0447]	EXM-MS-SSR-AI-0018	EXOMARS Rover Module Space Environment Requirements Specification
[NR 0106]	EXM-MS-SSR-AI-0005	EXOMARS Cleanliness and Contamination Control Requirements issue7
[NR 0119]	EXM-MS-RQM-AI-0010	SW PA Requirements for Subco's
[NR 0120]	EXM-MS-SSR-AI-0007	Planetary protection Implementation Requirements
[NR 0133]	EXM-MS-PLN-AI-0013	Planetary Protection Plan
[NR 0145]	EXM-MS-PLN-AI-00024	ExoMars EEE components control plan
[NR0438]	EXM-RM-SSR-AI-0015	ExoMars RM Cleanliness and Contamination Control Requirements
[NR0439]	EXM-RM-PLN-AI-0078	ExoMars RM Cleanliness and Contamination Control plan

2.1.3 ESA / NASA Normative Documents

[NR 015]	Moved as IR
[NR 021]	EXM-MS-RS-ESA-00013 - ExoMars Mission Environmental Specification
{NR A09]	ECSS-P-001A Glossary of Terms
[NR A10]	ECSS-Q-00A Policy and principles
[NR A12]	ECSS-Q-20B Quality Assurance
[NR A11]	ECSS-Q-20-04A Critical Item control
[NR A95]	ECSS-Q-20-07A Quality Assurance for test centres

[NR 015]	Moved as IR
[NR 085]	ECSS-Q-20-09B Non Conformance control system
[NR A14]	ECSS-Q-30B Dependability
[NR A13]	ECSS-Q-30-02A Failure Modes, Effects and Criticality Analysis
[NR 092]	ECSS-Q-ST-30-11C Derating - EEE Parts
[NR A16]	ECSS-Q-40B Safety
[NR A43]	Deleted
[NR A44]	Deleted
[NR A45]	Deleted
[NR A46]	Deleted
[NR A96]	RNC-CNES-R-15 CSG Nuclear Safety requirements
[NR A08]	ECSS-M-00-03B Risk Management
[NR 089]	ECSS-Q-ST-60C EEE Components
[NR 093]	ECSS-Q-ST-60-02C ASIC and FPGA development
[NR 095]	ECSS-Q-ST-60-05C Generic Requirements for Microcircuit
[NR A97]	ECSS-Q-ST-60-12C Design, Selection, procurement and use of die form monolithic microwave integrated circuits (MMICs)
[NR 098]	PSS-01-605 The capability approval programme for thin film microcircuits
[NR 099]	PSS-01-606 The capability approval programme for thick film hybrid microcircuits
[NR 090]	ECSS 12300 iss.1 Dec 2006 The EPPL and its management
[NR 099B]	ESCC 22900 iss.3 March 2007 Total dose Steady-State Irradiation test Method
[NR 099C]	ESCC 25100 iss.1 Oct. 2002 Single Event effects Test method and guidelines
[NR 07]	EXM-MS-RS-ESA-00005 Planetary Protection requirements
[NR A41]	ECSS-Q-70B Materials, mechanical parts and processes
[NR A17]	ECSS-Q-ST-70-01C Contamination and cleanliness control
[NR A18]	ECSS-Q-ST-70-02C Thermal vacuum outgassing test for the screening of space materials
[NR A19]	ECSS-Q-ST-70-03C Black anodizing of metals with inorganic dyes
[NR A20]	ECSS-Q-ST-70-04C Thermal cycling test for the screening of space materials and processes
[NR A21]	ECSS-Q-ST-70-05C Detection of organic contamination of surfaces by infrared spectroscopy
[NR A22]	ECSS-Q-70-07A Verification and approval of automatic machine wave soldering
[NR A23]	ECSS-Q-ST-70-08C The manual soldering of high-reliability electrical connections
[NR A24]	ECSS-Q-ST-70-09C Measurement of thermo-optical properties of thermal control materials
[NR A25]	ECSS-Q-ST-70-10C Qualification of printed circuit boards
[NR A98]	ECSS-Q-ST-70-11C Procurement of printed circuit boards
[NR A26]	ECSS-Q-ST-70-13C Measurement of the peel and pull-off strength of coatings and finishes using pressure-sensitive tapes
[NR A27]	EECSS-QST-70-18C Preparation, assembly and mounting of RF coaxial cables
[NR A28]	ECSS-Q-ST-70-20C Determination of the susceptibility of silver-plated copper wire and cable to "red-plague" corrosion
[NR A29]	ECSS-Q-ST-70-22C The control of limited shelf-life materials
[NR A30]	Deleted

[NR 015]	Moved as IR
[NR A31]	ECSS-Q-ST-70-22C The control of limited shelf-life materials
[NR A32]	ECSS-Q-ST-70-28C The repair and modification of printed circuit board assemblies for space use
[NR A33]	ECSS-Q-ST-70-30C Wire-wrapping of high-reliability electrical connections
[NR A34]	Deleted
[NR A35]	Deleted
[NR A35]	Deleted
[NR A36]	ECSS-Q-ST-70-36C Material selection for controlling stress corrosion cracking
[NR A37]	ECSS-Q-ST-70-37C Determination of the susceptibility of metals to stress corrosion cracking
[NR A38]	ECSS-Q-ST-70-45C Standard methods for mechanical testing of metallic materials
[NR A39]	ECSS-Q-ST-70-46C Requirements for manufacturing and procurement of threaded fasteners
[NR A40]	ECSS-Q-70-71A rev1 Data for selection of space materials and processes
[NR A99]	ECSS-Q-ST-70-06C The particle and ultraviolet (UV) radiation testing of space materials
[NR A100]	ECSS-Q-ST-70-38C High-reliability soldering for surface-mount and mixed-technology printed-circuit boards
[NR 56]	ISO 14644-1 Cleanrooms and associated controlled environments -Part 1: Classification of air cleanliness
[NR 57]	ISO 14644-2 Cleanrooms and associated controlled environments -Part 2: Specification for testing and monitoring to prove continued compliance with ISO 14644-1
[NR 58]	MSFC-SPEC-250 Protective Finishes For Space Vehicle Structures and Associated Flight Equipment, General Specification
[NR A42]	ECSS-Q-80B Software Product Assurance
[NR 084]	ECSS Standard - Space Project Management - Configuration and Information Management ECSS-M-ST-40C
[NR 050]	EXM-MS-RS-ESA-00027 ExoMars Tailoring of ECSS E40 Software Part 1B
[NR A47]	EXM-MS-RS-ESA-00029 ExoMars Tailoring of ECSS E40 Software Part 2B
[NR 03]	Moved as IR
[NR 01]	Moved as IR
[NR 65]	NASA-STD-6001 Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that support Combustions
[NR 66]	MIL-QML-19500 Semiconductor Devices
[NR 67]	MIL-QML-38534 Hybrid Microcircuits
[NR 68]	MIL-QML-38535 Integrated Circuits (Microcircuits) Manufacturing
[NR A101]	ECSS 9000 Integrated Circuits, Monolithic, hermetically sealed
[NR 70]	MIL HDBK 5 Metallic materials and elements for aerospace vehicle structures
[NR 71]	TBD KSC ELV Payload Safety (TBD)
[NR 097]	ECSS-Q-ST-60-14C Relifing Procedure - EEE Components
[NR 103]	ISO 14644-1 Cleanrooms and associated controlled environments -Part 1:Classification of air cleanliness
[NR 116]	Moved as IR
[NR TBD]	ECSS-Q-ST-70-31C Application of Paints and Coating on Space Hardware

[NR 015]	Moved as IR
[NR 128]	JPL D-64939 Launch Service Requirement Document
[NR 129]	AFSCPSMAN 91-710 V3 Air Force Space Command Manual, Vol. 3, 01/07/2004
[NR 130]	NASA-STD-8719.9 Standard for Lifting devices and Equipment w/Change 1
[NR 131]	10 CFR Part 71 & 49 CFR Parts 171 - 178 Transportation of radioactive material

--

2.2 Informative Documents

2.2.1 Definition of Informative Documents

Informative References are applicable to this document only when specifically called up in the text with specific indications of the parts of the document that are to be applicable. Otherwise the documents are listed below for information only as an aid for the purpose of understanding. For dated references, subsequent amendments to or revisions of any of these document apply to this list only when incorporated in it by amendment or revision. For undated references, the latest signed version is applicable and must be incorporated by the contractor in the project baseline .

2.2.2 Thales Alenia Space Italia Informative Documents

2.2.3 ESA / NASA Informative Documents

[IRA 111]	PSS-01-202 iss.1	Preservation, Storage, Handling and Transportation of ESA spacecraft hardware
[IR A04]	EXM-MS-RS-ESA-0007	Exomars Mission Objectives Document -
[IR A93]	EXM-MS-TNO-ESA-00017	ExoMars EEE Components Failure Modes Table
[IR A94]	EXM-MS-TNO-ESA-00016	ExoMars Low Temperature Qualification Guideline
[IR116]	CLSB-0409-1109, rev. 10a Atlas Launcher User Manual	
[IR01]	EXM-MS-RS-ESA-00001	Mission and System Requirements
[IR10]	EXM-RM-RS-ESA-00001	Rover Requirements
[IR03]	EXM-MS-RS-ESA-00012	Management Requirement Document
[IR015]	EXM-MS-RS-ESA-00010	ESA Document Requirements Description (DRD)
[NR0438]	EXM-RM-SSR-AI-0015	ExoMars RM Cleanliness and Contamination Control Requirements

CONTROLLED DISTRIBUTION



REFERENCE : EXM-MS-RQM-AI-0004

DATE : 21.01.2011

ISSUE : 05 PAGE :

[IRA 111]	PSS-01-202 iss.1	Preservation, Storage, Handling and Transportation of ESA spacecraft hardware
[NR0439]	EXM-RM-PLN-AI-0078	ExoMars RM Cleanliness and Contamination Control plan

3. PRODUCT ASSURANCE REQUIREMENTS

MS-PA-REQ-0010

Verification:

Traces:

A Product Assurance Program shall be implemented for the EXOMARS project which is properly planned and executed with sufficient authority and expertise with emphasis being placed on the optimization of design, safety aspects, timely prevention of deficiencies and verification of the adequate quality of the products and services to be supplied.

The spacecraft design and operation regime shall be developed in compliance with these requirements, which are applicable to the Sub-contractors and suppliers..

It is the responsibility of the contractor to allocate these requirements to sub-contractors and suppliers and to ensure their implementation.

It is emphasized that a policy of Prevention rather than Cure shall apply.

MS-PA-REQ-0020

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-10

The prime objective of the Contractors PA programme shall be to ensure that their own product and activity inside the ExoMars Programme will accomplish its intended objectives successfully. This shall be achieved in the most cost effective way.

3.1 Organisation and Management

MS-PA-REQ-0030

Verification: [MOD: A, T, RoD, I, S] [S/S: A, T, RoD, I, S] [EQP: A, T, RoD, I, S]

Traces: EXM-MS-RS-ESA-00002#PA-SY-20

The Subcontractor shall implement a PA programme.

The Product Assurance program to be carried out by the subcontractors and suppliers shall be in accordance with ECSS-Q-00A and shall include the disciplines of Quality Assurance; Software Product Assurance; Safety Assurance; Dependability; Component Quality, Selection and Procurement; Materials Parts and Process Selection and Control; Configuration management Control and Acceptance Activities.

MS-PA-REQ-0040

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-10

A Product Assurance Manager shall be assigned by the subcontractors and suppliers who shall be responsible to direct and to control the relevant Product Assurance program.

MS-PA-REQ-0050

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-10

The subcontractors and suppliers Product Assurance Manager shall have the authority to prevent implementation of project decisions which can adversely affect the quality of the spacecraft and shall have unimpeded access to higher company management for this purpose.

MS-PA-REQ-0060

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-10

The subcontractors Product Assurance Manager shall make sure that lower tier subcontractors have similarly approved Product Assurance organizations to perform tasks required for a proper control of the quality of the spacecraft during all phases of the project.

MS-PA-REQ-0070

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-10

Competent and sufficient staff shall be assigned and adequate facilities shall be made available to ensure proper and timely completion of all PA tasks.

MS-PA-REQ-0080

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-10

The planning of the PA activities and status control shall be integrated into the overall project planning to be implemented by the subcontractors and suppliers.

MS-PA-REQ-0090

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-10

The subcontractors and suppliers shall provide regular progress reports on the status of the Product Assurance program. Where convenient, the PA progress report shall be included as a separate section in the overall general project progress report.

MS-PA-REQ-0100

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-10

Product Assurance Manager shall support the progress meetings as planned in the contract and technical meetings as needed.

MS-PA-REQ-0110

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-30

In particular the outputs from the PA and Safety programme shall be linked to a Risk Management programme.

3.2 PA progress reporting(Addition to ECSS-Q-00A para 3.5.3)

MS-PA-REQ-0120

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-100

PA progress reporting shall be part of the overall project progress reporting and shall include as a minimum:

- Status of the PA activities since the last progress report (separated for the different disciplines eg QA, Dependability, Safety, EEE components, Materials & Processes, Software PA).
- outline of lower-tier subcontractors status
- alert status
- non-conformances status
- request for Deviation/waiver status
- critical items status
- explanation of performed activities
- planned accomplishments in next reporting period
- identified problems & risk factors
- activities planned to control identified problems & risk factors

- Risk management (technical), highlighting problems which may affect the customer requirements
- Accomplishments during the reporting period.
- Planned accomplishments in the next reporting period.
- Identified problems which may affect customer requirements, schedule and cost.
- Alerts assessment and status report.
- Accidents/ incidents.

3.3 Product Assurance Plan

MS-PA-REQ-0130

Verification:

Traces:

The subcontractors shall provide a ExoMars Product Assurance Plan for TAS approval in line with DRD PA-1 as per Document Requirements Description EXM-MS-RS-ESA-00010[NR 015]

MS-PA-REQ-0140

Verification:

Traces:

It shall become a formal and binding document which describes in detail the policy which will be implemented and the activities which will be carried out in order to fulfill the PA policy and requirements.

MS-PA-REQ-0150

Verification:

Traces:

The PA plan shall provide:

- A description of the Product Assurance responsibility and organization;
- A description of how the Product Assurance program will be implemented including critical areas for the ExoMars project and addressing each section of these PA requirements in the Product Assurance Plan;
- A Compliance Matrix wrt PA requirement document and for ECSS of level 1 and 2 (ECSS-Q-XX where Q = 00A; 20B; 30B; 40B; 60 B; 70B, 80B).
- A description of how the Product Assurance activities of the lower tier subcontractors will be defined and controlled.

MS-PA-REQ-0160

Verification:

Traces:

The basic planning of the Product Assurance activities with correlation to the various project milestones shall be included in the Product Assurance Plan.

3.4 Product Assurance data file and databases(Addition to ECSS-Q-00)

MS-PA-REQ-0170

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-110

All PA-related data and analyses (e.g., NCRs, SPRs, RFW, PA analyses, PA planning, alerts, EEE components list, Materials and processes lists, dependability/ Safety analysis, CIL, pictures, etc) shall be stored in an electronic database. This shall allow to import and export data from and to sub-contractors and the Customer.

MS-PA-REQ-0180

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-120

The subcontractor shall establish and maintain an up-to-date Product Assurance Data File. It shall contain but not be limited to:

- PA documents as identified in para. XX
- PA reports and technical notes
- PA meeting minutes and actions
- PA review and PA audit results
- Nonconformances tracking list and reports, including NRB minutes
- RFW reports and tracking lists
- Critical Item List (CIL)
- PA analyses
- MIP/KIP schedule, tracking list and reports
- Manufacturing Flow plans/charts
- Parts/Materials/Processes Lists with associated approval documents
- PMP Status Lists
- EEE parts lists
- EEE parts lists reference and approval status list
- PADs status list
- Alert status list

This data file shall be readily available and accessible to the TAS and ESA project personnel. Documents shall be delivered as defined in the Statement of Work.

It is recommended that the PA data file shall be summarized and made available in computerized

databases and as a minimum part, materials and processes lists, EEE parts lists as well as NCR status lists, including actions and configuration status lists shall be made available to TAS/ESA in a searchable and index sort able electronic form. The structure, contents and Database Management system shall be agreed with TAS/ESA.

The PA database shall be capable of importing and exporting data from and to TAS/ESA, in a mutually agreed format. It is recommended to use subcontractors in-house tools, already in use, provided that TAS/ESA are satisfied with functionality performance and compatible interfaces are established.

3.5 Subcontractors Suppliers PA Program

MS-PA-REQ-0190

Verification:

Traces:

Subcontractors Suppliers shall implement a Product Assurance program in accordance to the requirements of this document

MS-PA-REQ-0200

Verification:

Traces:

The PA program shall be described in the Suppliers PA Plan.

3.6 Right of Access, Participation

MS-PA-REQ-0210

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-40

TAS - ESA shall have the right of access to all technical and programmatic documentation, all areas and operations within the contractor's or supplier's facilities, in which work is performed or items are stored, which relate to the project even if the information is considered proprietary.

TAS/ESA will undertake not to disclose such information to a third party

MS-PA-REQ-0220

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-50

TAS/ESA shall have the right to perform or participate in audits, surveys, source inspection, test reviews, mandatory inspections (KIPs/ MIPs), Delivery Review Boards, Non conformance Review Boards etc at

the contractor or supplier facility.

TAS/ESA participation shall not in any way replace or relieve the subcontractors and suppliers of their responsibilities.

Arrangements shall be made to permit designated TAS/ESA personnel free access to all documentation, areas, and operations within the facilities of the subcontractors and suppliers in which work related to the ExoMars program is being performed.

Proprietary rights of the subcontractors and suppliers will be respected.

3.7 Approval Sequence

MS-PA-REQ-0230

Verification:

Traces:

Documents which have to be prepared by the suppliers and which are subject to review by TAS/ESA (e.g. Materials, Processes and Parts Lists) shall first be consolidated, reviewed and approved by the subcontractors before they are formally submitted to TAS/ESA.

3.8 PA involvement in overall project documentation

MS-PA-REQ-0240

Verification:

Traces:

The subcontractors PA shall be closely involved in the elaboration and review of the following documents (which do not fall directly under the full PA responsibility): test plan, test report, technical notes, Audit report, Minutes of meetings, Manufacturing Flow chart, Certificate of qualification.

3.9 Integration of lower data at higher level

MS-PA-REQ-0250

Verification:

Traces:

The subcontractors shall be responsible for integrating lower level data from subsystems, equipment, OTS into his level required documentation.

3.10 Qualification Status Reporting

MS-PA-REQ-0260

Verification:

Traces:

This chapter is a supplement to clause 6.6.4.4 of ECSS-Q-20B, which is also applicable.

MS-PA-REQ-0270

Verification:

Traces:

Subcontractors and suppliers shall give evidence of reached qualification, according to ExoMars requirements, providing a Qualification Status List (QSL).

MS-PA-REQ-0280

Verification:

Traces:

The document shall contain as a minimum:

- Categorization of Equipment
 - identification of hardware by name, Configuration Item/model/serial number;
 - supplier;
 - applicable qualification requirements (with reference documents) and relevant RFDs;
 - applicable documents which show the qualification achievement and relevant RFWs issued during the test campaign;
 - the qualification status (OPEN/CLOSED).
-

MS-PA-REQ-0290

Verification:

Traces:

In addition the QSL shall contain a paragraph with a complete and exhaustive description of modification implemented on flight hardware (e.g. design, materials, processes, EEE components changes). With respects to the hardware where the qualification achievement has been declared (e.g. FM versus EQM) including rationale for their acceptance

MS-PA-REQ-0300

Verification:

Traces:

Final issue of QSL shall be submitted at the flight hardware Delivery Review Board.

MS-PA-REQ-0310

Verification:

Traces:

In addition the subcontractors and suppliers shall provide at each project review a status list of proposed OTS to be used in the ExoMars project.

MS-PA-REQ-0320

Verification:

Traces:

The subcontractors shall demonstrate how the OTS complies with ExoMars requirements.

3.11 PA and Safety Plan (Addition to ECSS-Q-00A para 3.2)

MS-PA-REQ-0330

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-60

The contractor shall establish and maintain a PA plan to describe the resources, tasks, responsibilities, methods and procedures selected for the implementation of the PA and Safety requirements.

MS-PA-REQ-0340

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-70

The PA and Safety plan shall describe how the contractor intends to verify that the programme will be accomplished and how he intends to perform supervisory and monitoring actions on sub-contractors and suppliers.

MS-PA-REQ-0350

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-80

The PA and Safety Plan shall be supported by a compliance matrix against the normative requirements and the ExoMars Mission specific modifications cited in this document, including an organisation chart showing responsibilities and reporting. The contractor shall provide a justification and an equivalent



REFERENCE : EXM-MS-RQM-AI-0004

DATE : 21.01.2011

ISSUE : 05 PAGE :

alternative approach for any
non-compliance.

MS-PA-REQ-0360

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-90

The PA and Safety plan shall be delivered with the proposal, to be approved by TAS-I /ESA.

4. QUALITY ASSURANCE REQUIREMENTS

MS-PA-REQ-0370

Verification:

Traces:

The requirements stated in ECSS-Q-20B are applicable with the following modifications specified in this section.

4.1 Quality Assurance Plan

MS-PA-REQ-0380

Verification:

Traces:

The subcontractors and suppliers shall assign responsibility to suitably qualified and experienced staff for ExoMars Quality Assurance Management.

MS-PA-REQ-0390

Verification:

Traces:

The selected staff shall be responsible for the establishment and maintenance of all quality activities which are required by the ExoMars project.

MS-PA-REQ-0400

Verification:

Traces:

He shall make sure that all quality related requirements are understood and that qualified and certified personnel have been assigned to implement the quality assurance tasks.

MS-PA-REQ-0410

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-130

The QA plan shall be a part of the PA plan required by clause 3.4 of these requirements.

4.1.1 Normative documents

MS-PA-REQ-0420

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-140

This chapter is a supplement to clause 2 of ECSS-Q-20B. Where suitable, further existing documentation can be applied. Besides ECSS, this can be MIL, NASA or ISO standards. In case of conflict, ECSS standards shall prevail.

4.1.2 QA Surveillance

MS-PA-REQ-0430

Verification:

Traces:

QA surveillance for development and engineering models shall be proposed, as part of PA Plan, by the subcontractors and suppliers considering the complexity of activities, consequences of potential mistakes and relevant impact to the overall program.
It will be implemented upon received approval from TAS/ESA.

4.2 Requirements

MS-PA-REQ-0440

Verification:

Traces:

The quality assurance plan which defines how the subcontractors and suppliers will ensure compliance with the quality assurance requirements defined in this document, shall be part of the Product Assurance Plan.

4.3 PA Programme Audits

MS-PA-REQ-0450

Verification:

Traces:

Besides regular monitoring of the Product Assurance activities, the subcontractors shall plan and implement a program of audits on his own and on his lower tier subcontractors facilities and activities in

order to ensure that they are adequate for the intended applications and comply with applicable requirements

MS-PA-REQ-0460

Verification:

Traces:

The subcontractors shall prepare an Audit Plan (in line with DRD PA-2 of ExoMars PA-2 DRL/DRD") covering external and in-house audits and provide it to TAS/ESA for review and approval.

MS-PA-REQ-0470

Verification:

Traces:

More specifically, audits shall be performed to assess the overall capability to perform the necessary tasks required for the ExoMars project, if sufficient or satisfying audit data is not available.

MS-PA-REQ-0480

Verification:

Traces:

The first priority for audits shall be new suppliers and suppliers using new technologies

Audit shall be performed by the subcontractors using a check list.

MS-PA-REQ-0490

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-170

It is responsibility of the authority that will perform the audit, to prepare the check list and present it to TAS/ESA with the audit notification at the latest for approval. At the end of the audit, the subcontractors shall prepare the audit report to be submitted to TAS/ESA within two weeks.

MS-PA-REQ-0500

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-180

The report shall include: identification of areas of non-compliance or weakness, corrective actions with due dates, conclusions with statement on the acceptability to proceed with the activities, and the completed audit checklist.

MS-PA-REQ-0510

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-160

Audits shall be notified to TAS/ESA 10 working days in advance. TAS/ESA reserve the right to participate to the audits and to request additional audits performing.
Assembly and test facilities which may be used for the ExoMars project shall be certified to ECSS-Q-20-07 or verified to be able to meet the project need.

4.3.1 Audits (Addition to ECSS-Q-20B para 4.6)

MS-PA-REQ-0520

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-150

The Subcontractor shall establish an Audit plan covering external and in-house audits linked to the Risk Management programme.

Thus new processes shall be audited.

Critical items will be audited on a case by case basis pending the risk management.

Auditing may be required by the customer.

Thus the audit planning shall also evolve with the risk monitoring.

4.4 Critical Items Control

MS-PA-REQ-0530

Verification:

Traces:

The ECSS Q-20B is applicable, with modifications, as per the following paragraphs: ECSS-Q-00 para 3.3.5b, ECSS-Q-20B para 4.8 and ECSS-Q-30B para 8.4 shall apply with the following supplement:

MS-PA-REQ-0540

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-190

Subcontractors and suppliers shall establish and maintain an integrated Critical Items Control Program in line with ECSS-Q-20-04A.

The Critical Control Programme shall be subject to TAS approval.

The contractor shall identify those items which are a risk to the programme, e.g. unqualified processes,

unqualified materials, critical items from the dependability and safety analyses, special software, special GSE, ... When the corresponding actions have been implemented, a close out reference shall be added

4.4.1 Critical Item definitions

MS-PA-REQ-0550

Verification:

Traces:

The definition of "critical item" shall be applied to all those elements which have for various reasons a reduced degree of confidence about their own performance in operations if not adequately controlled on ground, during the development, manufacturing and test phases.

MS-PA-REQ-0560

Verification:

Traces:

Their criticality may have impact on different areas - such as reliability, safety, fracture control program or operating time.

MS-PA-REQ-0570

Verification:

Traces:

The following definitions and ranking criteria shall be applied:

Id	A) Safety/Reliability and Qualification Critical Items
SPF	Critical Single Point Failures: SPF with a severity category 1 & 2 at System level SPF classified as safety Catastrophic or Critical (Categories 1H and 2H). As they will already be managed through Hazard Analysis, the CIL will only reference them
TST	- Adequate ground testing at subsystem or system level is difficult or not practicable - Redundant items without possibility of independent check out after integration
QUA	- Items not qualified: no previous space qualification achieved on components, materials, processes, technologies - High sensitivity to manufacturing processes is expected - Materials with principal characteristics unknown - Items with exceptional qualification circumstances and/or process sensitivity, - Items which are highly radiation sensitive - Equipment with a known history of flight failures - EEE items developed for the mission (hybrid, MCM, ASIC, FPGA, detector, custom

	MMIC)
	• Special software • Special GSE
	B) Fracture Critical Items
FCI	• Structural items whose failure can result in catastrophic or critical hazards.
	C) Limited time availability Critical Items
LIF	• Limited life, limited cycle items: critical in terms of useful life duration or operating cycles limitation. All the items subjected to wear out, drift or degradation below the minimum required performance in less than the storage and mission time • Obsolescent EEE parts: components which will be discontinued or that will no longer be available
	D) Items with long supply or manufacturing time
LNG	• Long Lead Items (>12 months) • Items with ITAR restriction
	E) Planetary Protection critical items
PP	• Items, technologies and operations having impacts on Planetary Protection requirements fulfillment.

MS-PA-REQ-0580

Verification:

Traces:

Maximum effort will be made to eliminate the possible causes of criticality identified during the early phases of the program.

MS-PA-REQ-0590

Verification:

Traces:

In case the risk cannot be eliminated, adequate solutions or preventive actions will be identified to reduce and/or control the risk, as identification of additional requirements, tests, checks, and verification of manufacturing processes.

MS-PA-REQ-0600

Verification:

Traces:

Provisions for Critical Items control shall be initiated as early as possible in the program and shall include actions in one or more of the following areas, in order of precedence: design, manufacturing, inspection, test, operation.

MS-PA-REQ-0610

Verification:

Traces:

Critical items shall be identified through standard PA control methods and design analysis to be in line with ECSS-Q-20-04A Annex C.

MS-PA-REQ-0620

Verification:

Traces:

Subcontractors and suppliers shall detail in the Critical Item List all issues that cannot be resolved and single point failures that cannot be eliminated with detailed retention rationale.

MS-PA-REQ-0630

Verification:

Traces:

The CIL produced by the supplier will be processed and approved by each customer of the ExoMars customer/supplier chain.

MS-PA-REQ-0640

Verification:

Traces:

The CIL will take inputs from lower level CIL, in a build-up process to generate the subsystems and spacecraft higher level CIL.

MS-PA-REQ-0650

Verification:

Traces:

Criticality classification will be assessed to rank lower level effects and establish their resulting influence on higher level functions.

MS-PA-REQ-0660

Verification:

Traces:

[] Progress Report shall contain the status of Critical Items, including the updated Critical Items control forms.

MS-PA-REQ-0670

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-200

These risk items shall be tracked and controlled via the project risk management programme, which shall be reported on a monthly basis except where failures occur these shall be reported within 2 working days.

Significant changes or additions to the Critical Items List shall be included in regular PA status reports.

4.5 Non-conformance Control System, RFW and Deviations

MS-PA-REQ-0680

Verification:

Traces:

ECSS-Q-20-09B shall apply with the following modifications:

- Review of lower level NCRs will be performed by TAS/ESA on a regular basis (for instance at the progress meeting).
 - The subcontractors shall give visibility upon TAS/ESA request of all NCRs generated within the contract.
 - TAS/ESA reserve the right to reconsider NCR classification for subcontractors and suppliers NCRs (including product NCRs).
-

MS-PA-REQ-0690

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-210

Subcontractors and suppliers shall make available all NCR reports with attachments on an internet based application visible to TAS/ESA. This application will be the NCTS tool. This application shall be used to process all NCRs, generated within ExoMars program.

MS-PA-REQ-0700

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-220

The TAS/ESA shall concur in the disposition of any NCR affecting system requirements, a science instrument and all system level NCRs.

MS-PA-REQ-0710

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-230

All major non-conformances shall be notified to the Customer within 2 working days.

MS-PA-REQ-0720

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-240

Accidents/ incidents shall be processed according to the non-conformance control system and treated as major non-conformance. The reporting shall be done in accordance to ECSS-Q-40B [NR A16], paragraph 4.9 and Annex E.

Any non-conformance affecting the [NR 07] requirements shall be classified and reported major non-conformance.

MS-PA-REQ-0730

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-260

The NCRs numbering shall follow a project system as defined in the management requirement document EXM-MS-RS-ESA-00012 Para 2.1.2

For planned departure from requirement, the subcontractors and suppliers shall submit a request for deviation as required in ECSS-M-40B para 5.3.2.6

For unplanned departure from requirement, the subcontractors and suppliers shall issue an NCR major. When the NCR disposition is "use as is" or "repair", the NRB will assess the necessity of RFW issuing, in accordance to ECSS-Q-20-09B para 5.5.4.

Subcontractors shall include subcontractor and suppliers NCR, RFW, RFD tracking lists in regular PA status reports.

Suppliers shall include supplier and products NCR, RFW, RFD tracking lists in regular PA status reports.

4.5.1 Failure analysis

MS-PA-REQ-0740

Verification:

Traces:

Failure analysis, which may be destructive, and other investigations shall be performed on the nonconforming items only when and as required by the NRB.

4.6 Waivers

MS-PA-REQ-0750

Verification:

Traces:

In addition to ECSS-Q-20B para 5.6.9

Waiver submittal shall be done by electronic mean as reference and also in paper.

MS-PA-REQ-0760

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-280

The RFWs numbering shall follow a project system as defined in the management requirement document EXM-MS-RS-ESA-00012 Para 2.1.2

4.7 Alert System

MS-PA-REQ-0770

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-320

This chapter supersedes clause 5.7 of ECSS-Q-20B.

CPPA as well as users shall participate to the ESA alert system and screen alerts and problem notification as a day by day activity of the component control plan.

For self-procured components, the user is responsible to perform the tasks described in these paragraphs.

The applicable ESA alert procedure is available on line: <http://alerts.esa.int>.

4.7.1 Details about Alert / Problem notification see para. 7.3.9 of this document

MS-PA-REQ-0780

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-290

The subcontractors shall participate in the Alert System established by ESA, for the prompt interchange of information on failures/problems which may affect more than one user, or may recur in other projects or circumstances, if no preventive actions are taken.

The subcontractors shall ensure that relevant PA experts are involved in:

- The assessment of any failure to be reported to TAS/ESA as a potential for raising an alert by ESA
- The investigation, until disposition of the item subject of the potential alert
- The assessment of incoming alerts for the definitions, implementation and follow up of necessary actions
- The applicability and a preliminary assessment shall be communicated to TAS/ESA within 5 working days.

MS-PA-REQ-0790

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-300

The subcontractors shall ensure that all subordinate suppliers also participate (at least indirectly) in the ESA Alert System.

MS-PA-REQ-0800

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-310

This includes, as a minimum, that the subcontractors distributes all ESA Alerts to the lower tier suppliers and that there is a method of collecting and assessing inputs from lower tier suppliers to provide inputs to the ESA Alert System where warranted.

Alert Status and resolution of alerts shall be included in regular PA status reports. This alert status reporting shall cover SW production environment (e.g. compilers/production SW and COTS).

4.8 Cleanliness and Contamination Control

MS-PA-REQ-0810

Verification:

Traces:

Cleanliness and Contamination Control requirements are contained in the TAS specification EXM-MS-SSR-AI-0005 - EXOMARS Cleanliness and Contamination control Requirements [NR106] with the following supplement:

- All requirements relevant the cleanliness levels identified by ECSS process documents have to be considered.
- The subcontractors and suppliers shall evaluate the specific needs of contamination prevention, monitoring and control at all stages of handling, testing, integration, transportation and operation for spacecraft components and they shall provide facilities and implement procedures which prevent contamination in accordance with requirements and guidelines outlined in [NR106].

Deleted.

MS-PA-REQ-0820

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-340

All MAIT (manufacture, assembly, integration and testing) activities shall be performed in an ISO class 8 clean room or cleaner in conjunction with the applicable Planetary protection EXM-MS-SSR-AI-0007[NR 0120].

MS-PA-REQ-0830

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-350

The Contractor shall identify the hardware and facilities that require specific controls for molecular or particulate contamination. This includes e.g. ultra-cleaning for hardware coming in contact (or surfaces in direct view to such hardware) with Mars samples. Definition of requirements, their means of verification and control shall be stated.

Deleted.

MS-PA-REQ-0840

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-370

The introduction of the additional requirement of bioburden for planetary protection requires the consideration of all three entities (molecular contamination, particulate contamination, bioburden) in conjunction.

MS-PA-REQ-0850

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-380

In addition to par 6.5 in the ECSS-Q-ST-70-01A 'Packing, containerization, transportation and storage', the condensation of moisture or contaminants on cold surfaces during test or transportation shall be prevented.

MS-PA-REQ-0860

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-390

Whenever possible, optical equipment shall be closed and purged with ultra-clean nitrogen or synthetic air, to eliminate outgassing products and prevent molecular and particulate contamination.

MS-PA-REQ-0870

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-400

The allowed particulate, bioburden and molecular contamination levels shall be agreed with the subcontractors and instruments providers, based on Planetary protection requirements and/or acceptable performance losses.

4.8.1 Cleanless and contamination control Plan

MS-PA-REQ-0880

Verification:

Traces:

All Subcontractors and Suppliers shall prepare a Cleanliness and Contamination Control Plan to be approved by TAS-I (PA-8), strictly related to their own Planetary Protection Plan. The C&CCP shall also include the definition of necessary tests, test's schedule, related efforts, compliance matrix to CC requirements imposed by TAS-I.

4.9 Test Facilities

MS-PA-REQ-0890

Verification:

Traces:

This chapter supersedes clause 9.1 of ECSS-Q-20B.

MS-PA-REQ-0900

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-410

The subcontractors and suppliers shall ensure that test facilities, either internal or external, comply with ECSS-Q-20-07.

MS-PA-REQ-0910

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-420

The subcontractors and suppliers shall ensure that test facilities are suitably qualified to perform the tests to be conducted, and do not cause any degradation to the test article or its interface. This compliance shall be confirmed during the test readiness reviews (TRR).

4.9.1 Test Performance Monitoring

This chapter is a supplement of clause 9.4 of ECSS-Q-20, which is also applicable. If a test has a hazard potential with consequence severity of category critical or catastrophic, the test procedure shall highlight the nature of the hazard, and the hazard controls and safety devices shall be specified at the relevant operational steps. Test procedures shall be signed by subcontractors or suppliers PA function.

4.10 Test Reports

This chapter is a supplement to clause 9.3.2 of ECSS-Q-20B, which is also applicable. Each test report shall contain a conclusion stating the actual achievement of test objectives and shall identify any specific deficiencies. Test Reports shall include reference to NCRs relevant for the test subject of the test report.

4.11 End item Data package (EIDP)

MS-PA-REQ-0920

Verification:

Traces:

This chapter complements clause 10.2 of ECSS-Q-20B.

MS-PA-REQ-0930

Verification:

Traces:

The subcontractors and suppliers shall prepare the EIDP for any deliverables as per applicable SOW.

MS-PA-REQ-0940

Verification:

Traces:

Lower level EIDPs shall be maintained and relevant data shall be integrated into higher level EIDP.

MS-PA-REQ-0950

Verification:

Traces:

The EIDP shall be in accordance to ECSS-Q-20B Annex C (and B).

MS-PA-REQ-0960

Verification:

Traces:

It shall contain, as a minimum:

- certificate of conformance
- as-built configuration list (including DCL "as built")
- temporary installation records (e.g. remove-before-flight items)
- open / deferred work, open tests, missing items
- proof load certificate
- cleanliness and PP certificate
- integration, operation and maintenance manual (including engineering drawings and electrical/functional schematics)
- special packaging, handling and shipping procedures
- packing list (including loose items and spares)
- MIP/KIP tracking list
- MIP reports
- design and verification compliance matrix
- acceptance test reports
- interface control document
- logbook
- DRB minutes of meeting
- critical items list
- limited life items list
- CIDL
- qualification status list
- status lists (NCRs-RFDs-RFWs)
- non-conformances reports (major and minor)
- request for deviations

- request for waivers
- verification control document
- CE Certifications and ITAR Certification (for extra Europe import item)

MS-PA-REQ-0970

Verification:

Traces:

The EIDP shall be delivered in hard copy plus CD ROM support 15 days before the relevant DRB, for review

MS-PA-REQ-0980

Verification:

Traces:

Final hard copy plus final CD ROM support shall be delivered together to the item.

4.12 Delivery review boards

MS-PA-REQ-0990

Verification:

Traces:

This chapter is a supplement to clause of ECSS-Q-20B para. 10.3.

MS-PA-REQ-1000

Verification:

Traces:

The Delivery Review Board (DRB) shall be chaired by the P.A. Manager, or his delegated, of contractual authority.

MS-PA-REQ-1010

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-450

TAS/ESA reserves the right to attend DRBs at any lower level of suppliers as board member

MS-PA-REQ-1020

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-460

Any DRB shall be notified to TAS/ESA at least 10 working days in advance.

4.13 Packaging, Marking and Labelling, Transportation

MS-PA-REQ-1030

Verification:

Traces:

This chapter is a supplement to clause 10.4.1, 10.4.2 and 10.5.2 of ECSS-Q-20B, which is also applicable.

The detailed requirements for Marking, Packaging and Labelling, and Transportation referred to in Paragraphs 10.4.1, 10.4.2, and 10.5.2 of ECSS-Q-20B are defined in PSS-01-202 Para 2.1.3 and are the detailed applicable requirements.

MS-PA-REQ-1040

Verification:

Traces:

Each separately identifiable part or sub-assembly shall carry an identification consisting of at least the following information:

- a) Identification number
- b) Item title
- c) Model identification
- d) Serial number

MS-PA-REQ-1050

Verification:

Traces:

All parts or subassembly having the same identification number shall be functionally and dimensionally interchangeable.

4.14 Handling, Storage, Preservation

MS-PA-REQ-1060

Verification:

Traces:

This chapter is a supplement to clause 3.8 of ECSS-Q-20B, which is also applicable.

MS-PA-REQ-1070

Verification:

Traces:

The detailed requirements for handling, storage and preservation referred to in paragraphs 5.8.1, 5.8.2 and 5.8.3 of ECSS-Q-20B are defined in ESA PSS-01-202 Para 2.1.3 and are the applicable detailed requirements.

4.15 Inspections (PA-SY-465)

MS-PA-REQ-1080

Verification:

Traces:

In addition to ECSS-Q-20B para 8.9 the following requirements shall apply:

MS-PA-REQ-1090

Verification:

Traces:

The subcontractors and suppliers shall define beside the Key Inspection Points (KIPs) the Mandatory Inspection Points (MIPs).

MS-PA-REQ-1100

Verification:

Traces:

The subcontractors and suppliers shall reflect these KIPs/MIPs in the Manufacturing Inspection Plan (including the manufacturing flow chart as required by ECSSQ-20B para 8.2.2 to be provided to TAS-I/ESA for approval.

MS-PA-REQ-1110

Verification:

Traces:

TAS/ESA shall be invited to the selected MIPs.

MS-PA-REQ-1120

Verification:

Traces:

MIPs shall be notified 10 working days in advance

MS-PA-REQ-1130

Verification:

Traces:

MIPs shall be performed by Subcontractor/Supplier PA/QA responsible

MS-PA-REQ-1140

Verification:

Traces:

The finding of each MIP/KIP shall be documented and recorded as MIP/KIP reports, to be delivered to TAS/ESA.

MS-PA-REQ-1150

Verification:

Traces:

The MIP/KIP tracking list will be part of the PA status reporting and included in the EIDP.

MS-PA-REQ-1160

Verification:

Traces:

Special emphasis shall be placed to connect the critical items programme with the MIP/KIP programme. TAS/ESA shall have the right to select its MIP/KIPs from the Contractors' MIP/KIP list. TAS/ESA may

elect to add to the Contractor proposed MIP/KIPs if so necessary.

TAS/ESA shall be notified by formal communication of the actual date for planned MIP/KIP events:

- A MIP shall require invitation at least 10 working days before the event, and participation of TAS/ESA or its written agreement to proceed without TAS/ESA participation.
- A KIP shall require the same invitation, but the notified activity may be performed as scheduled if there is no reaction from TAS/ESA.

MS-PA-REQ-1170

Verification:

Traces:

The notification shall contain, as a minimum:

- Item identification
- Reference to the MIP/KIP List
- Supplier and location of inspection activity, contact personal
- Planned date and duration
- Any proposal change to the event as identified in the MIP/KIP list.

4.16 Electrostatic Discharge Control

MS-PA-REQ-1180

Verification:

Traces:

Electrostatic Discharge (ESD) Control has to be implemented for manufacturing, storage, inspection, assembly and test activities under Subcontractor and Supplier responsibility.

MS-PA-REQ-1190

Verification:

Traces:

The ESD Control will be supported by:

- the requirements and associated rules description
- the verification methods and periodicity
- periodic audits
- failed parts record and destructive physical analyses, as necessary
- Personnel training

5. DEPENDABILITY

5.1 Dependability Assurance

MS-PA-REQ-1200

Verification:

Traces:

[] The contractor shall analyse the product to verify compliance with the dependability and Safety requirements.

The contractor shall reduce and control all dependability and safety risks that lead to the non conformance to dependability and safety requirements.

The contractor shall provide identification of undesirable events leading to the loss or degradation of product performances, together with their classification into categories related to the severity of their consequences.

The contractor shall investigate the possible scenarios leading to the occurrence of undesirable events, and shall identify related failure modes, failure origins and causes, detailed failure effects.

The contractor shall identify hazards related to the production, assembly, handling, operation of the hardware and software system under his responsibility, and shall implement means of reducing and controlling the hazards so as to minimize the consequences to personnel, flight hardware, launch vehicle and facilities, the Earth and Mars environment.

MS-PA-REQ-1210

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-470

The Subcontractor and Supplier shall assign responsibility to suitably qualified and experienced staff for ExoMars Dependability Management.

MS-PA-REQ-1220

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-480

The Subcontractor and Supplier shall be responsible for the establishment and maintenance of all dependability activities which are required by the ExoMars project.

MS-PA-REQ-1230

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-490

The Subcontractor and Supplier shall participate in the approval of design documents to make sure that dependability requirements are suitably defined and implemented (e.g. derating, redundancy policy etc.).

MS-PA-REQ-1240

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-500

The Subcontractor and Supplier shall review non-conformance reports, change requests and MRB decisions to ensure that any impact on the system reliability has been accounted for.

MS-PA-REQ-1250

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-510

The Subcontractor and Supplier shall report the progress of the dependability programme as part of the PA progress reporting.

5.2 Dependability risk reduction and Control

MS-PA-REQ-1260

Verification:

Traces:

All Q-30 Para. 6 "Dependability risk reduction and control" is applicable.

5.3 Dependability engineering

MS-PA-REQ-1270

Verification:

Traces:

All Q-30 Para. 7 "Dependability engineering" is applicable with the modifications specified in the following paragraphs.

5.3.1 Design criteria

MS-PA-REQ-1280

Verification:

Traces:

This chapter supersedes Clause 7.3.1 "Consequence Category and Severity" of ECSS-Q-30.

MS-PA-REQ-1290

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-520

ExoMars Failure events on system and subsystem level that will affect mission success shall be classified on the basis of the severity of their consequences, according to the severity categories defined in the following Table 5.3-1 (this table supersedes in ECSS-Q-30-02 paragraph 4.2b and related table 1).

ExoMars Programme objectives

MS-PA-REQ-1300

Verification:

Traces:

The objectives of the ExoMars Programme will be pursued as part of a broad cooperation with NASA. Two missions are foreseen within the ExoMars programme for the 2016 and 2018 launch opportunities to Mars.

MS-PA-REQ-1310

Verification:

Traces:

The 2016 mission is an ESA led mission that will be launched by a NASA supplied rocket.

- ESA will supply a Mars Orbiter that will carry an Entry, Descent and Landing Demonstrator also supplied by ESA.
- NASA scientific instruments will be accommodated on the ExoMars Orbiter to support the search and localisation of Methane sources on Mars.

- The Orbiter will allow Mars proximity Data Relay support to the 2018 Rovers mission as well as any other international assets on the surface of Mars for about additional 4 years.

MS-PA-REQ-1320

Verification:

Traces:

The 2018 mission is a NASA led mission with the contribution of a Rover by ESA.

- The ESA Rover will be accommodated in a NASA-provided aeroshell and will share the journey with a NASA supplied Rover. Both Rovers will arrive at the same site on Mars and start independent surface missions after safe landing and egress from the landing platform.

MS-PA-REQ-1330

Verification:

Traces:

The ExoMars Programme objectives and their allocation to the mission are specified as follows:

ExoMars Programme Objective	2016 Mission (OM+EDM)	2018 Mission (RM)
Technology		
T1: Entry, Descent and Landing (EDL) of a payload on the surface of Mars (2016)	YES	
T2: Surface mobility with a Rover (2018)		YES
T3: Access to the sub-surface to acquire samples (2018)		YES
T4: Sample acquisition, preparation, distribution, and analysis (2018)		YES
Scientific		
S1: To search for signs of past and present life on Mars (2018)		YES
S2: To investigate the water/geochemical environment as a function of depth in the shallow subsurface (2018)		YES
S3: To study Martian atmospheric trace gases and their sources (2016 and 2018)	YES	YES
Programmatic		
P1: To support Mars proximity communications of international surface assets (2016)	YES	

Note: System and Subsystem level failure severity categories as defined in Table 5.3-1 shall be applied for each individual 2016 and 2018 mission.

5.3.1.1 Failure Consequence Severity Definition

MS-PA-REQ-1340

Verification:

Traces:

The definition of the consequence severity has been summarised in the following Table 5.3-1.

MS-PA-REQ-1350

Verification:

Traces:

[] A severity level shall be assigned to each assumed failure mode and each identified hazard according to its effect, defined without considering possible redundancy to compensate the effects of initial failure. The severity category for a particular failure mode shall be determined by the most severe effect of the failure considered (worst case).

- A suffix "R" shall be added to the severity category number if redundancy is provided.
- A suffix "SPF" shall be added to the severity category number for a single-point failure (no redundancy or back up implemented).
- A suffix "S" shall be added to the severity category number in case of hazard risk
- A suffix CM/CC shall be added to the severity category in case of common mode common cause failure

MS-PA-REQ-1360

Verification:

Traces:

SYSTEM LEVEL Dependability Severity Categories		
Level	Severity Category	Failure Effect Consequence
1	Critical	Loss of mission: • Loss of all Technology Demonstration Objectives or • Loss of “Surface Mobility with a Rover” Objective or • Loss of Programmatic Objective
2	Major	Major mission degradation: • Loss of two non critical Technology Demonstration Objectives, or • Loss of Payload support resulting in loss of all Science Objectives.
3	Significant	Significant mission degradation: • Loss of one non critical Technology Demonstration Objective, or • Loss of Payload support resulting in loss of one or more Science Objectives.
4	Negligible	Negligible: • Any other effect
SUBSYSTEM/ASSEMBLY/EQUIPMENT LEVEL Severity Categories		
Severity category Level	Failure Effect Consequence	
1	Propagation of failure to other subsystems/assemblies/equipment	
2	Loss of functionality.	
3	Degradation of functionality.	
4	Any other effect.	

Table 5.3-1 Failure consequence severity categories

Note:

- Subsystem level: e.g. Data Handling, Power, Guidance and Navigation, etc. for each Module
- Unit or Equipment Level: any unit or equipment belonging to a specific subsystem

5.3.1.2 Single Point Failure Definition

MS-PA-REQ-1370

Verification:

Traces:

[] Single Point Failure (SPF): an item or function for which no redundancy or back up is implemented in the design; a failure will result in the unrecoverable failure of the analysed product.

MS-PA-REQ-1380

Verification:

Traces:

[] Critical Single Point Failure:

- SPF with a consequence severity category 1 or 2.
- SPF with a consequence having hazard severity category 1 or 2 (i.e. Catastrophic or Critical due to safety reason)

MS-PA-REQ-1390

Verification:

Traces:

[] Single point failures with a consequence severity category 1, 2, 3 shall be summarised in a Single Point Failure List.

MS-PA-REQ-1400

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-730

[] Critical Single point failures which cannot be eliminated from the design with reasonable effort (or fault tolerance requirements which cannot be met) shall be tracked in the Critical Item List with a detailed retention rationale. They are subject to formal approval by ESA on a case-by-case basis.

MS-PA-REQ-1410

Verification:

Traces:

[] Multiple failures resulting from common cause or common mode failures shall be considered as single failures when determining failure tolerance.

5.3.2 Failure Tolerance

5.3.2.1 Basic requirements

MS-PA-REQ-1420

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-530

Clause 7.3.2.a of ECSS-Q-30 shall be read: "(a) The contractor shall verify the capability of the design to sustain single or multiple failures as defined by the following failure tolerance requirements:"

MS-PA-REQ-1430

Verification:

Traces:

[] Safety:

- No two hardware failures, two operator errors, a combination of a hardware failure and an operator error shall cause effects on any level of the ExoMars system of the Hazard Severity category 1
- No single hardware failure or operator error shall cause effects on any level of the ExoMars system of the Hazard Severity category 1 or 2.

Hazard Severity category definitions are provided in Table 6.3-1

MS-PA-REQ-1440

Verification:

Traces:

[] Dependability:

- No single hardware failure or operator error shall cause effects at System level of the severity categories 1, 2 as defined in Table 5.3-1.
- No single hardware failure or operator error shall cause effects at Subsystem or Equipment level of the severity categories 1, 2, 3 as defined in Table 5.3-1.

MS-PA-REQ-1450

Verification:

Traces:

[] Improper command or command sequences or software errors (e.g. originating from Single event Upsets) shall not cause damage of hardware and shall not result in operational conditions which cannot be restored by ground command.

This is also applicable for ground testing of flight hardware. Exceptions shall be approved by TAS/ESA and shall be reflected in the ExoMars User manual.

MS-PA-REQ-1460

Verification:

Traces:

[] The failure tolerance requirement does not apply to hazards/failures which are controlled by compliance with specific requirements other than failure tolerance, so called "Design for Minimum Risk" areas of design.

Note: examples are mechanisms, structures, glass, pressure vessels, pressurized lines and fittings, functional pyrotechnic devices, material compatibility, flammability, etc.

Controls related to these areas are extremely critical and warrant careful attention to the details of verification of compliance.

The failure tolerance requirement shall be applied to these designs as necessary to assure that credible failures that may affect the design do not invalidate the safety/margin related properties of the design. For example, a pressure vessel shall be certified safe based upon its inherent properties to withstand pressure loading that have been verified by analysis and qualification and acceptance testing (DMR); however, failure tolerance must be imposed upon external system that might affect the vessel, such as a tank heater, to assure that failures of the heater do not cause the pressure to exceed the maximum design pressure of the pressure vessel.

MS-PA-REQ-1470

Verification:

Traces:

[] The Subcontractor and Supplier shall describe in its Product Assurance Plan the strategy to be adopted for achievement of the minimum risk.

5.3.2.2 Additional specific requirements

MS-PA-REQ-1480

Verification:

Traces:

The following requirements are intended to drive the practical implementation of the previously expressed basic requirements.

It has to be noted that additional failure tolerance requirements for specific functions could be present in the system requirement documents derived from the "Mission and System Requirements Document" and "Rover Requirements Document"; if this is the case they will supersede the general requirements spelled out in this document.

Implementation of redundancy

MS-PA-REQ-1490

Verification:

Traces:

Redundancy concepts shall be considered to minimize consequences of single-point failures. Whenever practical, design based on redundant elements shall be implemented.

This shall include the use of redundant wiring, connectors and functions, where commensurate with mass etc. Specific redundancy requirements shall be defined in the applicable specifications/document sections.

MS-PA-REQ-1500

Verification:

Traces:

[] Where redundancy is employed, the design shall allow operating and verifying the redundant item/function independently from the nominal one.

MS-PA-REQ-1510

Verification:

Traces:

[] Each redundant path or function shall meet the full performance requirements

MS-PA-REQ-1520

Verification:

Traces:

[] The specified function and performance of each redundant element shall be capable of being measured during specified test phases.

MS-PA-REQ-1530

Verification:

Traces:

[] Cross strapping shall be incorporated in between chains of redundant units so that maximum overall reliability is achieved.

MS-PA-REQ-1540

Verification:

Traces:

[] Hot redundancy shall be provided for functions which could result in loss of mission if failing, according to mission phases.

MS-PA-REQ-1550

Verification:

Traces:

[] Interfaces redundancy shall be provided to avoid that a single failure in the nominal ones affects the full operability and performance of the redundant ones.

MS-PA-REQ-1560

Verification:

Traces:

[] Power: the primary power conversion and secondary power distribution inside each unit/equipment shall provide full redundancy.

MS-PA-REQ-1570

Verification:

Traces:

[] Execution of identified mission critical functions (severity 1 and 2) shall be implemented by two independently routed (nominal and redundant) commands/telecommands

MS-PA-REQ-1580

Verification:

Traces:

[] Unwanted execution of mission critical functions shall be prevented by implementation of arm/execute concept and multiple inhibit levels, according to the criticality of the function.

MS-PA-REQ-1590

Verification:

Traces:

[] All mission critical functions shall be observable by at least two independently obtained measurements

MS-PA-REQ-1600

Verification:

Traces:

[] Each Deployable device including activation mechanisms and retention system shall be single failure tolerant.

MS-PA-REQ-1610

Verification:

Traces:

[] On-board data processing, storage and transmission shall be structured in such way that single bit error per word does not disturb normal operation or activate redundancy.

MS-PA-REQ-1620

Verification:

Traces:

[] The Item (SYS, SS, EQP) design shall not include any failure propagation path such that any failure from one function/unit causes permanent failure to another function/unit of the item or other interfacing items. In particular, where redundancy is employed, a single failure in the nominal unit/equipment shall not affect the full operability and performance of the corresponding redundant unit/equipment.

MS-PA-REQ-1630

Verification:

Traces:

[] Redundant functions shall be implemented and/or routed physically separated or protected to prevent propagation of failures (mechanical, thermal, electrical, optical, biochemical contamination...) causing degradation or loss of the redundant ones. This is valid also to internally redundant units.

MS-PA-REQ-1640

Verification:

Traces:

[] Redundant function housed in a common box shall be separated by continuous metallic wall acting as heat sink and EMC shield.

Failure detection, isolation, recovery

MS-PA-REQ-1650

Verification:

Traces:

[] Each equipment, assembly, subsystem shall provide on-board failure detection capabilities.

MS-PA-REQ-1660

Verification:

Traces:

[] The anomaly detection system must ensure that only valid information is used.

MS-PA-REQ-1670

Verification:

Traces:

[] Autonomous failure detection and recovery shall not be based on a single sensor readout.

MS-PA-REQ-1680

Verification:

Traces:

[] All mission and safety critical functions shall be monitored by independent parameters.

MS-PA-REQ-1690

Verification:

Traces:

[] Anomaly detection shall be confirmed by using more than one sample of the same measurement.

MS-PA-REQ-1700

Verification:

Traces:

[] Spurious anomaly detection (false alarm) shall be avoided.

MS-PA-REQ-1710

Verification:

Traces:

[] Trigger limits shall have adequate and quantified margins.

MS-PA-REQ-1720

Verification:

Traces:

[] Trigger limits shall be adjustable on ground and in flight. Limits which are not adjustable or are hard-coded shall be clearly identified and specifically reported in the documentation.

MS-PA-REQ-1730

Verification:

Traces:

[] No single failure (or spurious event or false triggering) in the on-board protection system/ anomaly detection functions shall cause the Module to enter a safe/survival mode.

Comment: this may be waived if the design of the protection system functional chain can be shown to be inherently robust against spurious events or false triggering.

Failure Management

MS-PA-REQ-1740

Verification:

Traces:

[] Control laws and parameters for autonomous functions shall be capable of being modified by ground command.

MS-PA-REQ-1750

Verification:

Traces:

[] Fault management services, capable to monitor and control hazardous functions execution and recover in case of single failures occurrence, shall be provided.

MS-PA-REQ-1760

Verification:

Traces:

[] The time between the occurrence of the failure and the manifestation of the irreversible consequences (propagation time, T_p) shall be estimated for catastrophic and critical failure consequences, to allow proper definition of detection and recovery actions.

MS-PA-REQ-1770

Verification:

Traces:

[] In case a time-critical hazard that may affect mission objectives is detected, from which autonomous recovery and continuation of nominal operation is not possible, the affected unit shall be configured into a safe mode (when feasible) to await Ground Control intervention.

MS-PA-REQ-1780

Verification:

Traces:

[] The management of anomalies within a unit, subsystem or instrument shall be handled in a hierarchical manner such that resolution is sought on the lowest level possible.

MS-PA-REQ-1790

Verification:

Traces:

[] The fault management functions at all levels shall be able to carry out consistency verification checks on redundant sensor readings, whenever redundancy is available, before starting the recovery actions.

MS-PA-REQ-1800

Verification:

Traces:

[] Any automatic reconfiguration shall only be made from Prime to Redundant and not reverse.

MS-PA-REQ-1810

Verification:

Traces:

[] The implementation of any autonomous action shall avoid switching back and forth between unhealthy units.

MS-PA-REQ-1820

Verification:

Traces:

[] Switch over to redundant units shall be possible without affecting unrelated units.

MS-PA-REQ-1830

Verification:

Traces:

[] It shall be possible to enable, disable or reverse any on board autonomous function or action by ground command. Exceptions (e.g. DC/DC converters, over-voltage protections, etc.) shall be identified and agreed.

MS-PA-REQ-1840

Verification:

Traces:

[] A reliable procedure, under ground control, shall be provided to return to nominal operations after a failure.

MS-PA-REQ-1850

Verification:

Traces:

[] No nominal operation shall require the deactivation of the on-board protection system.

MS-PA-REQ-1860

Verification:

Traces:

[] Deployment mechanisms shall allow contingency operations to correct deployment anomalies (e.g. possibility to power up redundant winding of deployment motors, reverse operation of motors) by design features which do not introduce severe significant additional complexity.

MS-PA-REQ-1870

Verification:

Traces:

[] It shall be possible to reset the data handling subsystem without the need of the command to be processed by software.

MS-PA-REQ-1880

Verification:

Traces:

[] Any equipment containing rewritable memory devices shall allow its reading/writing for maintenance purpose during the mission.
This shall not cause interruption or degradation of the Module/System nominal activity.
It shall be possible to perform reading/writing under Ground direct control or by time-tagged commands.
Means to avoid inadvertent modifications shall be implemented.

5.3.3 Design approach

MS-PA-REQ-1890

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-540

The Supplier shall follow Clause 7.3.3 of ECSS-Q-30.

MS-PA-REQ-1900

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-550

In addition, for Fault Detection, Isolation and Recovery (FDIR), On Board reconfiguration handling, and accessibility the Contractor shall refer to the corresponding sections of the Mission System Requirements document.

Note: this could be part of the engineering activity.

5.4 Dependability Analyses

MS-PA-REQ-1910

Verification:

Traces:

All Q-30 Paragraph 8 "Dependability analysis" is applicable with modifications.

Clause 8.2.2 "Reliability analyses",

clause 8.2.3 "Maintainability analyses" and

clause 8.2.4 "Availability analyses" are superseded by the following paragraphs.

MS-PA-REQ-1920

Verification:

Traces:

[] During the preliminary design phase, the contractor shall classify functions, operations and products into criticality categories.

The criticality category of functions and operations shall be directly related to the severity of the consequences resulting from failure of the function or operation (e.g. a function whose failure induces a catastrophic consequence shall be classified with the highest criticality level).

The criticality category assigned to a product (hardware and software) shall be the highest criticality category of the functions associated to the product.

MS-PA-REQ-1930

Verification:

Traces:

[] The subcontractor shall establish and maintain a system to track the dependability recommendations originated by the dependability analyses until they are implemented.

MS-PA-REQ-1940

Verification:

Traces:

[] The subcontractor shall plan dependability analysis according to the project life cycle, development plan and review plan to demonstrate compliance with the dependability requirements.

MS-PA-REQ-1950

Verification:

Traces:

[] All the Analyses and documents shall be delivered in an electronic form to be agreed with the Prime, suitable for further processing and incorporation into higher level documents if necessary.

5.4.1 Functional Analysis (FA)

DELETED
DELETED
DELETED

5.4.2 Failure Modes, Effects and Criticality Analysis (FMECA)

MS-PA-REQ-1960

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-590

The FMECA shall be performed in accordance with the requirements from ECSS-Q-30-02
For failure analysis on circuit level EXM-MS-TNO-ESA-00017 shall be used as reference.

.

MS-PA-REQ-1970

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-600

FMECA items identified as a safety hazard shall include a cross reference to the corresponding paragraph in the Hazard Analysis, where those particular items are treated.

MS-PA-REQ-1980

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-610

Chapter 5 "Process FMECA" of ECSS-Q-30-02 does not apply.

MS-PA-REQ-1990

Verification:

Traces:

[] Lower level FMECAs, when available, shall be used as input in a build-up process to generate the subsystems and higher level FMECAs.
Severity classification will be assigned to rank lower level effects and establish their resulting influence on higher level functions.

5.4.3 Hardware/Software Interaction Analysis (HSIA)

MS-PA-REQ-2000

Verification:

Traces:

[] For equipment containing software, a Hardware/Software Interaction Analysis shall be performed to ensure that the software is designed to react in an acceptable way to hardware failures. This shall be performed at the level of the Software Requirements Baseline and Interface Requirements.

MS-PA-REQ-2010

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-620

The HSIA shall be performed in accordance with section 4.10 of ECSS-Q-30-02 and reflected in the FMECA.

5.4.4 Contingency Analysis

MS-PA-REQ-2020

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-630

ECSS-Q-30 section 8.2.2 c shall **not** apply.

5.4.5 Common Mode and Common Cause Failure analyses

MS-PA-REQ-2030

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-640

CMF and CCF analyses shall be performed to identify single potential causes capable to take out redundancy.

Comment: The analysis shall be performed as part of the FMECA

5.4.6 Reliability prediction

MS-PA-REQ-2040

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-650

ECSS-Q-30 Clause 8.2.2 g shall apply with the following addition:

A quantitative reliability requirement (numeric figure for probability of success) is not required for the ExoMars spacecraft composite. However, upon request by Prime/ESA, quantitative reliability assessment shall be prepared to show the reliability of the design and used for comparison of alternate design concepts on system, subsystem, equipment and unit level.

MS-PA-REQ-2050

Verification:

Traces:

[] The analysis details (e.g. failure rates, mathematical models, assumptions...) shall be provided.

MS-PA-REQ-2060

Verification:

Traces:

[] Reliability calculations shall take into account the possible exposure of all components to the environment (chemical, thermal, radiation, etc.) as defined by the applicable environmental, cleanliness and planetary protection requirements.

MS-PA-REQ-2070

Verification:

Traces:

[] MIL-HDBK 217F notice 2, taking into account the appropriate quality levels, shall be used preferably as the failure rate database. The part stress prediction method shall be used. Where components are not covered by MIL-HDBK 217F notice 2, individual failure rates shall be agreed with the Prime/ESA.

MS-PA-REQ-2080

Verification:

Traces:

[] Mechanical parts shall be addressed in the reliability prediction and the reliability data sources shall be provided.

5.4.7 Worst Case Analysis

MS-PA-REQ-2090

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-660

ECSS-Q-30 Clause 8.2.2.h applies.

MS-PA-REQ-2100

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-670

Mission specific aging and drift effects shall be evaluated on the basis of the mission environment, application conditions and manufacturer data.

5.4.8 Part derating analysis

MS-PA-REQ-2110

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-680

Each subcontractor shall deliver a Parts Stress Analysis and submit it to TAS-I/ESA approval as required in the DRD PA-14 and in the DRL in para 12.1 of the present document. Clause 8.2.2.i of ECSS-Q-30 applies with the following modification: ECSS Q-60-11 is replaced by ECSS Q-ST-30-11. Exomars Mission specific stresses will be reviewed to evaluate whether to apply additional/different derating.

5.4.9 Maintainability Assessment

MS-PA-REQ-2120

Verification:

Traces:

[] The Module/System/Subsystem/ layout shall permit an easy replacement of any equipment. The layout shall permit replacement of a unit without dismounting any unit other than the one to be replaced.

MS-PA-REQ-2130

Verification:

Traces:

[] Each subsystem/unit shall be designed to require a minimum of special tools and test equipment to maintain calibration and identify malfunctions. Each unit shall be designed to avoid necessity of routine maintenance and refurbishment once integrated with the Spacecraft.

MS-PA-REQ-2140

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-690

The Subcontractor and Supplier shall identify the preventive and corrective maintenance actions for ground operations, including storage, for both Flight Hardware and GSE. Emergency restoration or repair activities necessary to sustain system capabilities crucial to mission success and launch availability shall be also identified.

MS-PA-REQ-2150

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-700

The contractor shall identify in a maintainability report those items that cannot be checked after integration, that require late servicing, access or replacement, and limited-life items or consumables.

MS-PA-REQ-2160

Verification:

Traces:

[] The maintainability activities shall consider also the Ground Segment of ExoMars and related GSE, tools, models needed for the successful completion of the mission.

5.4.10 Availability analysis

MS-PA-REQ-2170

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-710

No numerical availability requirements have been defined for ExoMars. However, the Subcontractor and Supplier shall support any activity or analyses to derive outage frequency and duration if such an Analysis might be considered necessary for the project during the design and development phase.

MS-PA-REQ-2180

Verification:

Traces:

[] The availability activities shall consider also the Ground Segment of ExoMars and related GSE, tools, models needed for the successful completion of the mission.

5.4.11 Hazardous commands identification

MS-PA-REQ-2190

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-720

The Subcontractor and Supplier shall identify any command or command sequence that can cause consequences:

- of the safety severity category 1 ("catastrophic") or
- dependability severity category 1 or
- cause damage to flight hardware if issued inadvertently or not issued when required (out of sequence commanding).

The identified hazardous commands shall be reflected in the Hazard Analysis (DRD PA-19).

5.5 Inputs to Critical items list (CIL)

MS-PA-REQ-2200

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-730

ECSS-Q-30 Para 8.4 "Critical items list" applies with the following modifications:

Clause 8.4.2 shall be read:

As minimum, Single Point Failure items of the hazard severity category 1 and 2 (catastrophic, critical) and dependability severity level 1 and 2 shall be listed and processed as critical items.

5.6 Dependability Testing

MS-PA-REQ-2210

Verification:

Traces:

The chapter 9 of ECSS-Q-30 [NR 7] applies with the following additional requirement:

MS-PA-REQ-2220

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-740

Dependability testing shall also verify the correct functioning and performance of the on-board FDIR capabilities.

Where ground intervention is required to perform FDIR for the flight segment to assure mission success the function and performance of these capabilities shall be verified end-to-end.

5.7 Failure Propagation

MS-PA-REQ-2230

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-750

No hardware or software failure shall propagate across the interface to a redundant item or functional path.

Note: Requirement does not apply for functions which depend on other functions (e.g. power). Design shall be such that failure in one function shall not cause a fault in any other function.

MS-PA-REQ-2240

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-760

No hardware or software failure of Ground Support Equipments shall cause damage to interfacing Flight Hardware.

6. SAFETY

6.1 General

MS-PA-REQ-2250

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-770

- [] ECSS-Q-40 [NR 10] shall apply with the following deletion, modification and supplements:
- The contractor shall assure that all hardware, software and activities to be performed during ground operations are compliant with existing national safety regulations at all locations where the equipment is manufactured or used and where ExoMars related activities are carried out.
 - Existing national regulation shall prevail in case of conflict with ECSS-Q-040 [NR 10] requirements.

MS-PA-REQ-2260

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-780

- [] Accidents and incidents shall be reported as defined in ECSS-Q-40 [NR 10], paragraph 4.9.

MS-PA-REQ-2270

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-790

A Safety program shall be established by the Subcontractor and Supplier to achieve the following objectives:

- to preserve EXOMARS system during ground operations.
- to preserve operations personnel, GSE, and ground facilities.
- to minimise hazards to the general public and private property.
- to protect the launcher vehicle including other launcher payloads
- to protect the environment and to comply with the planetary protection requirements

MS-PA-REQ-2280

Verification:

Traces:

- [] The Safety effort will be directed:
- to identify potential hazards during ground operations.
 - to eliminate the hazards from the design, where possible.
 - to minimise and/or control the non-eliminated hazards (residual hazards)

- to recommend management decision to resolve hazards, or to assume the residual risk.
- to document those areas for which a decision has been taken to assume the risk, including the rationale for the decision.
- to implement appropriate control measures for residual hazards.
- to support the Safety Review Process for the pertinent responsibility level
- to certify that the ExoMars Spacecraft Composite (including the Descent Module, the Rover Module and all the scientific experiments) is safe and complies with the applicable Safety requirements for the pertinent responsibility level.

MS-PA-REQ-2290

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-800

The safety programme shall ensure compliance to the Launch Authority safety requirements and the applicable international and national safety regulations (including the legal European Union requirements related to the product liability where appropriate) during design, manufacturing, integration, testing, handling, transportation and launch.

MS-PA-REQ-2300

Verification:

Traces:

[] The Launch Site and Launcher safety requirements and regulations are fully applicable and must be considered as design drivers for the complete spacecraft system, spares, GSE and all activities at Launch site.

MS-PA-REQ-2310

Verification:

Traces:

[] The Subcontractor is responsible to ensure the safety of his products. The safety programme relates to flight hardware and associated Ground Support Equipment is under the responsibility of the subcontractor.

MS-PA-REQ-2320

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-810

The Subcontractor and Supplier shall identify and plan all activities required to obtain approval from the launch authority.

MS-PA-REQ-2330

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-820

The Subcontractor and Supplier shall deliver the documentation requested by the launch authority.

MS-PA-REQ-2340

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-830

The Subcontractor and Supplier shall submit all required safety data package to TAS/ESA and he is responsible for the correct implementation of the safety requirements towards TAS/ESA. In addition he shall support ESA in all activities related to safety towards the launch authority including participation in all safety reviews which are required in the applicable documents. It is the responsibility of the contractor to determine whether more stringent safety requirements are applicable via requirements specified elsewhere for other locations where equipment is used or activities carried out for the ExoMars project (e.g. for equipment being transported by air). The contractor shall assure compliance to such requirements.

PA-SY-840 Deleted

MS-PA-REQ-2350

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-850

The acceptance rationale for residual hazards shall identify the reasons the hazard cannot be eliminated, all provisions and controls which are applied to reduce the hazard to an acceptable level.

MS-PA-REQ-2360

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-860

Protection systems shall, to the greatest extent possible, be intrinsically fail safe and shall be capable of being enabled and disabled by commands.

MS-PA-REQ-2370

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-870

For safety certification, the Subcontractor and Supplier shall certify that the flight and ground system products are in compliance with the requirements of the applicable standards as well as any applicable

ExoMars specific safety requirements, in accordance with ECSS-Q-40, paragraph 4.2. In case the verification process is not completed, the certification shall include a statement that open verification shall be closed in accordance with the established verification tracking log and do not affect further safe processing at third party premises.

MS-PA-REQ-2380

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-880

The Subcontractor and Supplier shall ensure that for testing and general handling of the spacecraft at third party premises, the required Ground Support Equipment has a valid calibration/acceptance certification for the planned activities.

6.2 Safety Management and Planning

MS-PA-REQ-2390

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-890

In addition to ECSS-Q-40 paragraph 4.2.2 the following requirement shall apply:

MS-PA-REQ-2400

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-900

The Subcontractor and Supplier project safety management shall be familiar with national and international safety standards, health requirements and the requirements of the launch facilities. He shall make sure that hardware manufactured and used within the project is safe and that any required safety certification is obtained well prior to any intended use in order to avoid any delay in the progress of the project.

MS-PA-REQ-2410

Verification:

Traces:

Nuclear Safety Authority

The RHU units are an ESA/NASA furnished equipment for the ExoMars mission.

The Nuclear Safety Authority is responsible for checking that all the nuclear activities of a space project related to a space vehicle with nuclear sources on board are in conformance with the relevant

regulations and providing the associated authorizations.

MS-PA-REQ-2420

Verification:

Traces:

[] The main contractors in charge of the design of main elements containing the RHU (e.g. Rover Module) shall appoint a Nuclear Safety Representative.

This function shall be in charge of assessing engineering design compatibility with the safety requirements (this task is different from the RHU integration activities).

MS-PA-REQ-2430

Verification:

Traces:

[] The contractors shall provide adequate expertise available to support the engineering function with respect to the peculiar nuclear safety needs.

The composition of the industrial teams shall give evidence accordingly and provide CV's of dedicated team members.

C: This requirement should be able to be met by a team member with functional competence but not necessarily dedicated entirely to this task.

MS-PA-REQ-2440

Verification:

Traces:

[] The contractors shall provide the safety data packages in compliance with the Launch site and the Nuclear Safety Authority requirements.

MS-PA-REQ-2450

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-910

The Subcontractor and Supplier Project Safety Management shall review system and subsystem specifications to ensure that these specifications address the project specific safety requirements and that compliance is adequately verified by analyses, reviews of design, test, and/or inspection and that this verification is fully documented. Project Safety representatives shall participate in all system design reviews and provide evidence that the specific objectives and tasks of each project phase are met.

MS-PA-REQ-2460

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-920

The Subcontractor and Supplier Project Safety Management shall make sure that the safety requirements are known and implemented by all contractors participating in the project.

MS-PA-REQ-2470

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-930

The Subcontractor and Supplier shall describe in his Product Assurance Plan or in a separate Safety Assurance Plan the detailed tasks and the procedures which will satisfy the requirements defined in the applicable documents. The task descriptions and procedures shall include those to be performed and to be applied by his co- and subcontractors.

MS-PA-REQ-2480

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-940

The planning of the safety assurance activities shall correspond to the ExoMars milestone planning and the dates for safety submissions and safety reviews as required by the launcher authority. Adequate margins, which have to be agreed by ESA, shall be included in the planning to allow for review of safety data packages by ESA and for potential corrections before the data packages have to be submitted to the launch authority.

6.3 Hazard Severity Categories

MS-PA-REQ-2490

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-960

ECSS-Q-40 Paragraph 5.3 Table 1 shall be superseded by the following table.

MS-PA-REQ-2500

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-970

The consequences of a risk related to safety are classified in categories as defined in the following table.

Severity of identified hazards and consequences

Severity of identified hazards and consequences		
Level	Severity Category	Consequence
1	Catastrophic	- Loss of human life; life threatening, permanently disabling injury or occupational illness, or - Loss of launch site facilities, or - Severe detrimental environmental effects on earth
2	Critical	- Temporarily disabling but not life-threatening injury to persons, or temporary occupational illness, or - major damage to ground facilities or private/public property, or - major detrimental environmental effects on earth..
3	Marginal	- Minor injuries to persons, or minor occupational illness, or - minor damage to or deterioration of property, including the earth environment

Table 6.3-1: Hazard severity categories

MS-PA-REQ-2510

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-980

Failure modes or activities which (e.g. in case of human error) can lead to consequences classified as category 1, 2 or 3 shall be identified. Potential hazards of category 1 and 2 shall be reported in Hazard Reports, according to relevant DRD.

MS-PA-REQ-2520

Verification:

Traces:

[] Safety critical items shall be monitored and tracked in the CIL as part of the project risk management approach.

6.4 Hazard Analysis/Residual Hazards

MS-PA-REQ-2530

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-990

The Subcontractor and Supplier shall carry out hazard analyses as early as feasible and in parallel to the design activities and to the preparation of activities with plans and procedures in order to identify potential hazards, to eliminate them as far as practical and as required and/or control them to acceptable levels.

MS-PA-REQ-2540

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1000

The Subcontractor and Supplier shall perform hazard analyses and demonstrate how the hazards are controlled. Residual hazards shall be subject to approval by ESA as well as any non compliance to safety requirements (per Request for Waiver).

MS-PA-REQ-2570

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1010

The Subcontractor and Supplier shall deliver Hazard Analyses for every design review and before every major integration and test campaign on equipment-, subsystem- and system level.

MS-PA-REQ-2580

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1020

Residual Hazards shall be identified and acceptance rationales shall be provided for these reviews on suitable form sheets for formal approval by TAS/ESA.

MS-PA-REQ-2590

Verification:

Traces:

[] Additional specific safety analyses: the Subcontractor and Supplier shall perform additional safety analyses (such as venting analysis, leak-before-burst analysis, and dedicated thermal analysis of pressurized assemblies), as required by the launcher authority or ExoMars TAS/ESA, to support the safety review process. The outcome of these analyses shall be formally documented through technical notes.

MS-PA-REQ-2600

Verification:

Traces:

[] The Contractor shall demonstrate that results of the safety analyses confirm that the design is in agreement with the launch authority requirements.

6.5 Safety engineering

MS-PA-REQ-2610

Verification:

Traces:

[] Reduction precedence shall be applied to identified hazards, hazardous conditions and functions whose failures have hazardous consequences, as detailed in ECSS-Q-40B § 5.2.3:

- Hazard elimination
- Hazard minimization
- Hazard control: Safety devices
- Hazard control: Warning devices
- Hazard control: Special procedures

MS-PA-REQ-2620

Verification:

Traces:

[] Inherent safety shall be mandatory for design selection.

MS-PA-REQ-2630

Verification:

Traces:

[] Safe without service: whenever the safe operation of the system depends on externally provided services (e.g. power, cooling fluids, etc), the system design shall be such that critical or catastrophic consequences are not induced (at least for a certain interval of time that shall be defined for each project) after the loss or upon the sudden restoration of those services.

MS-PA-REQ-2640

Verification:

Traces:

[] Whenever feasible, a fail-safe design approach shall be used such that a failure brings the product in a safe state.

MS-PA-REQ-2650

Verification:

Traces:

[] The product design shall provide the capability for detecting failures that result in degradation of failure tolerance with respect to the hazard detection, signaling and safing function. The performance of these functions shall be verifiable during flight and ground operational phases.

MS-PA-REQ-2660

Verification:

Traces:

[] Emergency, warning and caution data, out of limit annunciation and safing commands shall be given priority over other data processing and command functions.

MS-PA-REQ-2670

Verification:

Traces:

[] Material selection shall assure that potential hazards associated with material characteristics are either eliminated or controlled. If this is not feasible, the design of the system and its parts shall include the necessary provisions to control potential hazards associated with material characteristics.

MS-PA-REQ-2680

Verification:

Traces:

[] Execution of functions which are identified as Safety critical (severity category 1 and 2) if not performed shall be implemented by two or three independently routed (nominal and redundant) commands/telecommands, according to the criticality of the function.

MS-PA-REQ-2690

Verification:

Traces:

[] Unwanted execution of hazardous functions shall be prevented by at least two or three barriers, according to the hazard severity.

MS-PA-REQ-2700

Verification:

Traces:

[] Commanded execution of hazardous functions shall be implemented by means of two independent commands (arm and execute concept). Hazardous functions are those which when executed at the incorrect time could cause effects according the Severity classification provided.

MS-PA-REQ-2710

Verification:

Traces:

[] Pyrotechnics and actuators: all pyrotechnic releases shall be redundant. Redundancy shall be provided by duplication up to and including the initiators and to the mechanism interface as required.
C: The term "pyro" or "pyrotechnic" is hereafter used indifferently to mean also other types of one-time actuators such as Non Explosive Actuators, Non Contaminating Actuators, One-shot actuators, thermal knives and similar. Where peculiar characteristics have to be addressed (e.g.: induced shock, contamination, safety hazards etc) they shall be specifically mentioned by the Contractor.

MS-PA-REQ-2720

Verification:

Traces:

[] High reliability and safety shall be provided for pyrotechnic devices by the use of approved practices including the shielding of all leads and electronics

MS-PA-REQ-2730

Verification:

Traces:

[] All pyrotechnics shall be initiated via spacecraft dedicated interfaces. All pyrotechnics commanding path shall incorporate the required safety inhibits.

MS-PA-REQ-2740

Verification:

Traces:

[] Any pyrotechnic actuation/separation system shall be self contained before and after operation, i.e. no released components or debris are allowed.

6.6 Failure tolerance

MS-PA-REQ-2750

Verification:

Traces:

[] Failure tolerance is a basic safety requirement that shall be used to control hazards.
The failure tolerance requirements are defined in Para. 5.3.2 Failure Tolerance of these Product Assurance Requirements.

MS-PA-REQ-2760

Verification:

Traces:

[] Multiple failures, which result from common-cause or common failure mechanisms, shall be considered as single failures for determining failure tolerance.

MS-PA-REQ-2770

Verification:

Traces:

[] Alternate or redundant safety-critical functions shall be physically and functionally separated or protected in such a way that any event that causes the loss of one path shall not result in the loss of alternative or redundant paths.

MS-PA-REQ-2780

Verification:

Traces:

[] Hardware or software failures shall not cause additional failures with hazardous effects or propagate to cause the hazardous operation of interfacing hardware.

MS-PA-REQ-2790

Verification:

Traces:

[] Design for minimum risk: potential hazards arising from structural failure of mechanical component that cannot have redundant back-up, such as mechanisms, structures, pressure vessels, pressurised lines and fittings or from toxicity, material compatibility and flammability, shall be controlled by safety related properties and characteristics of the design, to assure that hazards associated with material characteristics are either eliminated or controlled.

Comment: Such provisions may include safety factors, fracture control for pressure vessels, fail safe design or containment, adequate materials selection (compatibility with environment, with sterilization process, avoidance of flammable/toxic/outgassing materials), supported by prototyping & qualification, design for testability during development and integration.

MS-PA-REQ-2800

Verification:

Traces:

[] No single failure or single human error shall cause loss of the emergency and warning functions together with the monitored functions.

MS-PA-REQ-2810

Verification:

Traces:

[] Protection systems shall, to the greatest extent possible, be intrinsically fail safe and shall be capable of being enabled and disabled by commands.

6.7 Software

Deleted

6.8 Product Liability Requirements

MS-PA-REQ-2820

Verification:

Traces:

[] In addition to safety analyses, the subcontractor will address specifically the requirements issued by the European Union in terms of product liability and related directives.

MS-PA-REQ-2830

Verification:

Traces:

[] The subcontractor shall identify for each product under his responsibility the applicability of the EU directives.

MS-PA-REQ-2840

Verification:

Traces:

[] The liability requirements shall apply to every product (flight product and ground support equipment) under the responsibility of the subcontractor.

MS-PA-REQ-2850

Verification:

Traces:

[] Where applicable, the subcontractor shall perform the related certification towards the EU directives.

MS-PA-REQ-2860

Verification:

Traces:

[] The subcontractor shall perform for each product under its responsibility a safety assessment report in line with the safety analysis.

MS-PA-REQ-2870

Verification:

Traces:

[] After compliance assessment the subcontractor shall deliver a formal liability Declaration of Conformity mentioning the legal data asserted by the EU directives.

7. EEE COMPONENTS

7.1 General

MS-PA-REQ-2880

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1040

The ECSS-Q-ST-60 [NR 089] applies with the amendments specified here below. The requirements of ECSS-Q-ST-60 [NR 089] for Class 2 components (para. 5 and **Table 7-2: Quality levels for Class 2 components) quality level ESCC and MIL** shall apply in the Exomars project, unless explicitly tailored or modified in the next paragraphs. The quality level "others" shall not be applied for ExoMars. In the event of conflict in requirements, this document shall prevail.

MS-PA-REQ-2890

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1050

The requirements reported in this section apply to any EEE parts used in flight hardware or to parts which come in direct contact with flight hardware.

For Engineering and/or engineering qualification standard hardware the paragraph 7.4.07 applies whilst the requirements for GSE parts are reported in paragraph 7.4.8.

MS-PA-REQ-2900

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1070

The following items shall not be considered EEE components and will be controlled at unit or higher level by the relevant disciplines:

- intermediate products containing discrete components on substrates - PCBs,
- motors
- solar cells,
- cells in batteries,
- HF sub-assemblies like coaxial cable assemblies or waveguide elements,
- TWTs,
- and RF switches, coaxial or waveguide.

7.2 EEE Program management

MS-PA-REQ-2910

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1090

The subcontractor shall implement an EEE Components Control Programme in accordance with all the requirements of ECSS-Q-ST-60C para. 5, taking into account the additions and exceptions as defined below in this section. In the event of conflict with ECSS-Q-ST-60C para. 5, this document shall have precedence in ExoMars Mission project.

7.2.1 Procurement policy

MS-PA-REQ-2920

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1100

ExoMars Mission EEE parts procurement is based on a co-ordinated approach.

The EEE components will be procured through a Co-ordinated Procurement Agency under TAS/ESA control.

The CPPA under TAS/ESA direction will enforce since the design phase a program for control and selection of components, which will ensure maximum use of qualified parts, minimise the number of part types, guarantee the radiation tolerance required by the mission, assess the compatibility with sterilization techniques, harmonise as far as possible the experimenters and the satellite users needs/schedule, minimize the ITAR covered items and keep them under a tight control with the goal of achieving an effective component standardisation.

In order to cope with the stringent program schedule a Preferred Parts List will be prepared as one of the first agency B2 task. The EXO-PPL will be reviewed and approved by the Exo-PCB during early phase B2.

The PPL will not be limited to EPPL and NSPL listed qualified components, but will be a living document listing those critical functions that are needed by the users applications and need a particular effort in standardization due to delta qualification effort, different package layout, etc.

Any subsystem/unit contractor (called user in this context) shall use the EXO-PPL as baseline for the components selection.

MS-PA-REQ-2930

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1110, EXM-MS-RS-ESA-00002#PA-SY-1120

Periodical dedicated meeting, EXOMARS Parts Control Board (EXO-PCB), are convened (in accordance to EXM-MS-PLN-AI-0024) among CPPA TAS and ESA. Components manufacturers and users will be invited as necessity. The EXO-PCB members have the following tasks:

- To manage and control the part procurement program at all levels

- To implement the Parts Approval cycle through PAD approval including review of part/manufacture evaluation/qualification plan and test reports (if applicable), status of qualification, approval of procurement specifications, quality and lot acceptance levels and procurement inspections, DPA, radiation sensitivity assessment.
- To review the procurement status and to identify risks like U.S. parts under Export license restrictions, ITAR.
- To assess parts technical issues such as Non-conformances, Waivers, Deviations and alerts. PCBs will be held as a minimum until the approval of all parts has been finalized and the procurement of most critical items successful concluded.

7.2.2 User tasks in EXO-PCB

MS-PA-REQ-2940

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1130

Subcontractors, called users in this context, shall propose through DCL the procurement approach for each item clearly defining the relevant need dates for EXO-PCB approval.

As general approach, co-ordinated procurement shall be the preferred approach. Users shall procure as much as possible through the coordinated channel and shall pro-actively cooperate with CPPA in the standardization task providing if necessary technical justification for the selection of part types not included in EXO-preferred part list/master part list.

Users shall support CPPA and TAS with his specific expertise for selecting suitable part manufacturers, providing background information for the preparation of specifications, type approval/screening programs and approval documents.

Users are requested to nominate within their ExoMars team, a key person responsible to interface the CPPA for any technical, programmatic or financial issue. This point of contact shall have also the task to participate to the communication system that will be implemented in the program; he shall be requested to participate to the standardization process, to the EXO-PCB on request, to NCR process whenever applicable. He shall also act as point of contact between CPPA/EXO-PCB and engineering, quality and purchasing department of the relevant company.

Even in case of full coordinated procurement, users are considered fully responsible concerning selection and application of EEE parts with respect to the project requirements.

They also are considered responsible for self-procurement of special parts not supplied through CPPA. The Self-procurement will be authorized on a case by case basis. Typical examples of self procured items are:

- Customized items
 - Unique parts/exotic parts
 - ASIC
 - MMIC
 - In-house manufactured hybrids / add-on dice parts for hybrid
 - Parts that were selected late in the project (e.g. due to late functionality definition, NCR corrective action), for which the user could not place the purchase order within the CPPA established cut-off dates.
- Users shall interface directly the CPPA to define orders, quantity, lead time and recurrent cost. The direct cost for parts ordered for the ExoMars flight units shall be paid directly by the relevant users to CPPA. The indirect or non-recurring cost shall be included in the total charge for the general services provided by the CPPA in the frame of the contract. All services for parts ordered by the CPPA for the

EXO units after the cut-off date (as it will be defined in the frame of early phase B) shall be fully charged to the concerned user.

In case of unique part the EXO-PCB reserves the right of accept it for coordinated procurement but charging all the not recurrent costs to the relevant user.

7.3 Declared Component List

Users shall issue a Declared Components List, as per ECSS-Q-ST-60C para 5.1.4, identifying all component types needed and this list will be kept under configuration control. Bullet d and bullet f of the above mentioned ECSS paragraph are not applicable to Exomars programme.

The list shall be generated in tabular format organized by family and group.

The DCL shall be compatible with electronic transmission and shall be provided also in an unlocked .pdf format with meta-data filled in.

Any change after equipment CDR or during equipment manufacturing shall be managed through updating of DCL and PAD approval process.

The list shall report for each line item the proposed procurement approach (co-ordinated or self) and the need quantity splitted between engineering need quantity and manufacturing attrition. In case of self-procurement the relevant line item shall report the approval status of the PAD. Users shall clearly indicate the need date for FM components.

The DCL format applicable to Exomars project will be provided by TAS-I.

These Declared Component Lists shall be submitted to TAS/ESA via EXO-PCB for acceptance of the proposed procurement approach and for starting the co-ordinated procurement. Users shall then update the DCL for the established program reviews as requested in the SOW.

In case the subcontractor is responsible of subsystem, the DCL shall be presented as aggregated of lower level lists with identification of open/critical issues and status of consolidation (RID open/close, expected updating, status of EE parts approval, etc.).

It shall be a CPPA task to provide for each EXO-PCB an updated master parts list organized by group and family of the parts approved for centralized procurement within ExoMars programme reporting the approval status of the relevant PADs.

7.3.1 As built DCL

MS-PA-REQ-2950

Verification:

Traces:

The "as built" DCL, taking into account the EEE parts actually installed in the equipment and their Date Code, shall be provided for approval as part of EIDP.

MS-PA-REQ-2960

Verification:

Traces:

The "as built" DCL shall list passive components one line item for each P/N (that is, not for range). The engineering quantity per P/N shall be reported as well.

7.4 EEE Components Selection / Qualification

MS-PA-REQ-2970

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1150, EXM-MS-RS-ESA-00002#PA-SY-1170, EXM-MS-RS-ESA-00002#PA-SY-1490

As general rule, parts included in ExoMars hardware shall be selected in the EXO-PPL established by CPPA/Major S/S contractor/TAS/ESA in the phase B and regularly updated up to CDR. Parts included in EXO-PPL will be selected as primary basis, in the following lists:

- ESCC 12300 European Preferred Parts List Part 1 (downloadable at <https://escies.org>)
- Nasa Parts Selection List Grade 2 plus any additional test required in the NPSL for that part (available at <http://nepp.nasa.gov>)

In any case, the selection of each part/technology shall be driven by its status of qualification.

The selection of high reliability EEE parts shall be based therefore on the knowledge regarding technical performance, qualification status and history of previous usage in similar applications with maximum use of qualified parts and with established reliability history.

Preference shall be given to parts from sources that would necessitate the least evaluation/qualification effort.

EEE parts shall be selected in compliance with the requirements of the project (Mission life, operating stability, materials, planetary protection, safety, quality, reliability) and to withstand all environmental conditions including tolerance to radiation exposure (total dose, single events and displacement damage effects for active parts).

As second stage the selection shall take into account:

- minimization and standardization of the number of different generic part types and families
- parts from multiple sources are preferred

The EXO-PPL will contain as well the list of components that will be covered by the Low temperature evaluation campaign that CPPA is conducting under TAS-I and ESA direction to extend the storage temperature range down to -130°C.

Any new developed item for the mission (hybrid, MCM, ASIC, FPGA, detector, custom MMIC) shall be considered as a critical item for the unit and the status of its development shall be tracked in the CIL and updated for each unit progress meeting.

TAS and ESA shall be invited to attend to dedicated major design reviews as appropriate for the relevant technology.

For non standard parts, that is parts not included in the above mentioned lists, the procurement responsible shall put in place a configuration control system to ensure that any change of the product (i.e. mask, manufacturing or assembling process) affecting evaluation, performance, quality, reliability and interchangeability is communicated to him by the manufacturer (e.g. EPN).

In case of change, the procurement responsible shall inform the subcontractor.

The subcontractor shall ensure the compatibility of the change with its application.

The change shall be submitted to customer up to ESA for approval.

7.4.1 EEE components requirements on materials and processes

MS-PA-REQ-2980

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1180

Users shall be requested to ensure all materials which are not hermetically sealed within components meet the requirements of ECSS-Q-70B regarding off-gassing, out gassing, flammability, toxicity and/or other criteria defined by the intended use.

MS-PA-REQ-2990

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1190

The procurement authority (CPPA for co-ordinated items, users for self-procured items) shall select components taking into account the ExoMars Planetary protection requirements in [NR 07],. The compatibility of any part with such requirements will be assessed and confirmed by EXO-PCB as part of the review and approval of its selection.

MS-PA-REQ-3000

Verification: [S/S: RoD]

Traces: EXM-MS-RS-ESA-00002#PA-SY-1200

According to ECSS-Q-70, the Subcontractor shall be able to demonstrate the adequacy and the qualification status of his mounting and assembly rules for each package technology and material.

As a minimum, the mounting procedure shall address :

- compliance to ECSS-Q-ST-70-08C
- Design of Printed Circuit Boards or any support receiving EEE parts (thermal requirements, rules for implantation of EEE parts, ...)
- Storage and handling on the assembly line,
- Preparation of EEE parts before mounting,
- Mounting process, in compliance with maximum rating authorized by the specification (component whose internal construction uses metallurgic bonding with a melting temperature not compatible with the end application mounting conditions shall be avoided)
- Criteria for visual inspection,
- Storage conditions of Printed Circuit Boards or any support receiving EEE parts.

These procedures shall be available for review by TAS up to ESA, on request.

TAS/ ESA reserves the right of access to the qualification file for the mounting processes.

7.4.1.1 Prohibited materials and components

MS-PA-REQ-3010

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1160, EXM-MS-RS-ESA-00002#PA-SY-1210

For limited life, known instability, safety hazard or reliability risk reasons, the use of EEE parts as listed in ECSS-Q-ST-60 [NR 89] paragraph. 5.2.2.2/d shall be prohibited in ExoMars.

With respect of healthy and safety, if the listed materials are used in the standard design/manufacturing processes of a particular part type, their use must be approved on a case by case basis with the provision that its application does not constitute an unacceptable safety hazard:

- Beryllium oxide (except if the health and safety hazards are identified in the specification)
- Cadmium
- Lithium
- Magnesium
- Mercury
- Radioactive material
- Zinc
- all materials which may cause a safety hazard

7.4.2 Radiation Hardness Assurance

MS-PA-REQ-3020

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1230

On the basis of "ExoMars mission environmental specification" EXM-MS-ESA-RS-00013 Iss. 4 dr.0 users shall assess the radiation dose that their equipment will receive during all phases of the mission (transfer orbit, cruise and Mars orbit) performing a sectoring analysis of their unit and shall demonstrate that the radiation susceptibility of the parts is at least the radiation design dose that is 2 times greater than the expected total dose for the whole mission.

This will be part of the radiation analysis.

In agreement to the applicable mission dose depth curve, Total Design Dose (TDD) has been established considering the end of life deposited dose in the following configurations:

- Orbiter Electronic Units:
 - mission duration: 6,94 years
 - 2mm Al eq. from Spacecraft + 2mm Al eq. from box wall
 - EOL Dose = 7,96KRad - that gives a TDD=16KRad
- Entry Descent Landing Demonstrator Module (EDM):
 - mission duration: 296d (up to separation)
 - 2,04mm Al eq. from Shell+ 2,57mm Al. eq. from box walls (that is 2mm perpendicular from box walls) that gives 4,61 mm Al.eq.
 - EOL Dose = 1,63KRad - that gives a TDD=4KRad
- Rover Module Electronic Units
 - mission duration: 296d (up to separation) + 218 sols = around 520d
 - dose depth curve applicable to EDM (that is to 2016 mission, because Nasa mission data are not available at the time of writing)
 - 2,04mm Al eq. from Shell+ 2,57mm Al. eq. from box walls (that is 2mm perpendicular from box

walls) that gives 4,61 mm Al.eq.

- RHU contribution= around 1,7Krad (for a silicon target at a minimum distance of 5cm from one reference RHU plus the contributions of all the other RHUs at their places)
- EOL Dose =1,63KRad+1,7Krad=3,33 - that gives a TDD=7Krad

The TDT of 20 KRad shall be considered for the selection of EEE parts.

Components which have been proven by valid data to be susceptible to more or at least the TDT are suitable for ExoMars without additional testing and/or analysis.

When no or insufficient data are available for potential sensitive components and in case of components susceptible to less than 20 Krad the procurement authority has to perform the radiation verification test (RVT or RADLAT) on 5 samples of the procured lot presenting the results to EXO-PCB for lot approval.

MS-PA-REQ-3030

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1220

Due to the lot-to-lot variability in Total Dose effect, all active parts, will be submitted to Radiation Lot Acceptance Tests (RADLAT). As a general basis, the RADLAT testing matrix is given in table here below.

However, on a case by case basis, test criteria could be relaxed taking into account total dose data on previous lots. For example, for a given part/Manufacturer, if total dose behaviour is steady and if there is no technology modification, test frequency can be reduced. In any case, technical data shall justify this relaxation.

The generic RADLAT testing matrix is as follow:

MS-PA-REQ-3040

Verification:

Traces:

MOS / BiCMOS				BIPOLAR			
FAMILY	Test Criteria	Test Method	Dose Rate	Test Criteria	Test Method	Dose Rate	Sample Size
Zener Diodes				Existing data show that for EXO-mission they are insensitive	RD-1bis	High or Low	/
Transistors	All	RD-1bis or RD-3	High or Low	2	RD-1bis or RD-3	Low	5
Analog Ics	All	RD-1 or RD-3	Low (1)	All	RD-3	Low	5
Logic Ics	1	RD2 or RD3	Low (1)	4	RD3	Low	5
ASICs, FPGA	All	RD2 or RD3	Low (1)	All	RD3	Low	2-3
RAM, PROM, Processors	2	RD2 or RD3	Low (1)	6	RD3	Low	2
Optoe., CCD,	All	RD2 or RD3	Low (1)	All	RD3	Low	5

MS-PA-REQ-3050

Verification:

Traces:

(1) : For fully MOS technology devices High Dose Rate can be used

Table13-2-2-1 : Total Dose Screening Matrix

MS-PA-REQ-3060

Verification:

Traces:

With

- RD1 : MIL-STD-883G, METHOD 1019.7 condition C dose rate <0,1 Rad/S
- RD1bis: MIL-STD-750E, METHOD 1019.5 condition C with dose rate <0,1Rad/S
- RD2 : MIL-STD-883G, METHOD 1019.7 condition A with 50Rad/s - condition B for fully MOS device (dose rate to be agreed among the parties)
- RD3 : « Total Dose Steady State Irradiation Test Method ESCC Basic Specification N° 22900, issue 3, March 2007

CATEGORY	TEST CRITERIA
All	All diffusion lot tested
1	Lot tested if flight diffusion lot number different of data diffusion lot number and data date code older than 1 year.
2	Lot tested if flight diffusion lot number different of data diffusion lot number and data date code older than 2 year.
4	Lot tested if flight diffusion lot number different of data diffusion lot number and data date code older than 4 year.
6	Lot tested if flight diffusion lot number different of data diffusion lot number and data date code older than 6 year.
10	Lot tested if flight diffusion lot number different of data diffusion lot number and data date code older than 10 year.

Table 13-2-2-2 : RADLAT Test Criteria

MS-PA-REQ-3070

Verification:

Traces:

Low Dose Rate is lower or equal to 360 rad/hour (0.1 rad/sec).

MS-PA-REQ-3080

Verification:

Traces:

The RADLAT set up shall be tailored to cover the project requirements as per users input (that is worst application conditions among the different users configurations). In case of no or late input from the users the CPPA, for co-ordinated procured items, will establish the test bias conditions taking the worst case configuration as reported in the procurement specification.

MS-PA-REQ-3090

Verification:

Traces:

Silicon Nitride layer will be avoided unless RADLAT data demonstrates an acceptable total dose behaviour.

MS-PA-REQ-3100

Verification:

Traces:

Some device technologies are inherently hard to total dose ionizing dose effects. The following classes of parts are considered as total dose insensitive :

Non Zener Diodes	Not sensitive up to 300 Krad(si)
GaAs	Gallium Arsenide devices such as FETs and HEMTs show little parametric variation.
Std TTL Logic	Extensive testing on 54XX, 54L, 54S devices show these parts to be only marginally degraded
ECL	Emitter Coupled Logic devices exhibit little parametric shift out to several Mrad(si)
Microwave Devices	Step Recovery, Varactor, Schottky, Microwave Mixer and Multiplier Diodes exhibit negligible shifts
Quartz	No Total Dose testing required unless in Swept technology

MS-PA-REQ-3110

Verification:

Traces:

For these parts, deposited dose levels will be lower than 300 krad(si).

For Radiation Hardened parts, data have to be provided by the part manufacturer.

Components that have been proven by valid data/or dedicated test a sensitivity between 10 and 20Krad:

- for Orbiter application, shall be subjected to dedicated EXO-PCB and user approval on case by cases basis. Orbiter user radiation analysis shall support the approval.
- For EDM and Rover applications, can be used without any further provisions.

Components that have been proven by valid data/or dedicated test a sensitivity lower than 10 KRad:

- for any applications, shall be subjected to dedicated EXO-PCB and user approval on case by cases basis. Users radiation analysis shall support the approval.

For parts coming from lot that have been subjected to RVT test the margin factor can be reduced to 1,5.

MS-PA-REQ-3120

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1220

The Total dose assurance shall include the evaluation for bipolar and BiCMOS devices of Enhanced Low dose rate (0.01 rad/sec) sensitivity. The ELDR sensitivity shall be addressed in the RVT method and planning.

The procurement authority of EEE-parts (either the CPPA or the subcontractors) will be responsible of presenting an appropriate test plan for bipolar and biCMOS linear devices covering the ELDR sensitivity

for customer approval.

As reference purpose it is included a typical ELDR test methodology:

For bipolar and biCMOS linear devices the Dose Rate in RVT shall be ≤ 0.01 rad/s up to 10krad.

During irradiation the part will be biased in the worst configuration at room temperature. Then the test will be continued up to 20 krad with standard low dose rate of 0.1 rad/s. A step of room temperature annealing need to be added (e.g. 24hrs). This would mean around 12 days of test.

MS-PA-REQ-3130

Verification:

Traces:

For Rover the effect of residual gamma and neutron emission of RHU shall be considered in the radiation analysis.

7.4.2.1 Displacement damages and NIEL

MS-PA-REQ-3140

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1240

The utilization of optoelectronic, CCD, APS etc (silicon, Ga-As and other compounds) shall be analysed as far as sensitivity to proton induced displacement damage and generally to NIEL.

End of mission expected proton fluence normalized @ 10MeV is:

- Orbiter Electronic Units:

- mission duration: 6,94 years
- 2mm Al eq. from Spacecraft + 2mm Al eq. from box wall
- for silicon target EOL Total Fluence = $1.99 \cdot 10^{+10}$ that gives, with a safety factor of 2, a DDEF= $4 \cdot 10^{+10}$ 10 MeV eq. protons/cm²

- Entry Descent Landing Demonstrator Module (EDM):

- mission duration: 296d (up to separation)
- 2,04mm Al eq. from Shell+ 2,57mm Al. eq. from box walls (that is 2mm perpendicular from box walls) that gives 4,61 mm Al.eq.
- for silicon target EOL Total Fluence = $4.13 \cdot 10^{+9}$ that gives, with a safety factor of 2, a DDEF= $8.3 \cdot 10^{+9}$ 10 MeV eq. protons/cm²

- Rover Module Electronic Units

- mission duration: 296d (up to separation) + 218 sols = around 520d
- dose depth curve applicable to EDM (that is to 2016 mission, because Nasa mission data are not available at the time of writing)
- 2,04mm Al eq. from Shell+ 2,57mm Al. eq. from box walls (that is 2mm perpendicular from box walls) that gives 4,61 mm Al.eq.
- RHU contribution = around $2.3 \cdot 10^{+10}$ 10 MeV eq. protons/cm² (for a silicon target at a minimum distance of 2cm from one only reference RHU)
- EOL proton fluence = $2.3 \cdot 10^{+10} + 4.13 \cdot 10^{+9} = 2.7 \cdot 10^{+10}$ - that gives a DDEF = $5.4 \cdot 10^{+10}$ 10 MeV eq. protons/cm²

Each component shall have been tested to show immunity to the above reported EXO- p⁺ fluences.

7.4.2.2 SEE assurance

MS-PA-REQ-3150

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1250

All potential SEE sensitive components shall have been subjected to heavy ions/proton test. Validity of already available results and/or extension of test results to components manufactured in the same technology shall be evaluated and approved at EXO-PCB level. When no SEE sensitivity data are available, potential sensitive components will be subjected to heavy ions and/or proton test. The relevant test plan shall be submitted to EXO-PCB for review. The final test report shall then be submitted to TAS/ESA in the frame of EXO-PCB for component approval.

The responsibility of providing reliable SEE susceptibility data is on top of the procurement authority (CPPA for co-ordinated procured items, users for self procured items).

MS-PA-REQ-3160

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1260, EXM-MS-RS-ESA-00002#PA-SY-1300

A part will be considered Single Event Free if no event is observed, at LET_{equ.} > 60 MeV.cm²/mg; in addition for destructive events the parts will not experiment any event up to a fluence of 10⁷ ions/cm².

7.4.2.2.1.1

Components exhibiting a sensitivity between 15 MeV cm²/mg < LET_{th} < 60 MeV cm²/mg shall be subject to the appropriate Heavy Ion SEE rate predictions.

The SEE rate prediction results shall be used in the Radiation Analysis and in the FMECA for the system impact assessment

MS-PA-REQ-3170

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1270

As far as not permanent SEE as SEU (Single Event Upset)/SET (Single Event Transient) there is no requirement of minimum LET threshold or maximum cross section. Each subcontractor will include SEU/SET sensitive components in the SEE criticality analysis showing the suitability of the selected part within the unit application. The SEE criticality analysis shall be included in the Radiation Analysis or in the unit FMECA for the system impact assessment and upper level contractor/Prime/ESA approval.

MS-PA-REQ-3180

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1290

For digital technologies, the subcontractor will be required to use parts with a well known SEU sensitivity in terms of LET threshold and cross section.

The subcontractor shall include in the equipment radiation analysis the SEE rate prediction and analysis of effects of the possible identified events, showing that:

for all the memories the probability of uncorrectable errors shall be $1E(-11)$ error/ (bit*day).

SEU effect shall not induce unwanted lose of critical circuit:

- For critical function, a flight automatic recovery procedure shall be foreseen in order to avoid loosing mission for SEU effect
- EDAC, scrubbing of the memories, parity bit implementation Checksum verification, and algorithm to reduce corruption of memories contents shall be implemented. At least one error shall be corrected and 2 shall be identified
- Procedure to reset on demand volatile RAMS or FPGA for critical part shall be foreseen

MS-PA-REQ-3190

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1280

If the orbit is exposed to proton environment and if the Heavy Ions LET threshold is lower than 15 MeV.cm²/mg, components need to be submitted to high energy proton test. In case data are not available and upon customer approval, contractor can extrapolate the expected induced error rate by means of appropriate prediction tools (PROFIT, SIMPA, ...).

The applicable LET spectra curve is reported in the ESA "ExoMars mission environmental specification" EXM-MS-ESA-RS-00013. The relevant SEE criticality analysis shall be included in the Radiation Analysis or in the FMECA for the system impact assessment.

MS-PA-REQ-3200

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1310

In principle parts showing a LET threshold lower than 3,7MeV cm² /mg shall not be used. If it is used, the radiation hardness section of the relevant PAD shall in this case report exhaustively the reference to applicable test report and test method and condition and summary of test results

MS-PA-REQ-3210

Verification:

Traces:

For SET sensitivity the following requirement apply:
the subcontractor will perform a SET effect analysis in order to determine the effect of SET on equipment performance. The table provided here below can be used as reference of worst case pulse amplitudes and duration in case non reliable test data and/or equivalent table based on subcontractors specific experience are available.

OP-amps	$\Delta V_{\max} = +/ - V_{CC}$ & $\Delta t_{\max} = 15\mu s$
Comparators	$\Delta V_{\max} = +/ - V_{CC}$ & $\Delta t_{\max} = 10\mu s$
Voltage Reg.	$\Delta V_{\max} = +/ - V_{CC}$ & $\Delta t_{\max} = 10\mu s$
Voltage Ref.	$\Delta V_{\max} = +/ - V_{CC}$ & $\Delta t_{\max} = 10\mu s$
PWMS	Double pulses, two missing pulses, multiple missing pulses in a row, device shut off. Asses impact in specific application.

MS-PA-REQ-3220

Verification:

Traces:

For each application, subcontractor will demonstrate that a SET will not produce an out of specification and that the SET induced errors will not propagate outside the equipment. The subcontractor will provide an evaluation of the maximum pulse duration that his design will tolerate without detrimental effects. This analysis will be included in the radiation analysis/FMECA.

MS-PA-REQ-3230

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1250

As a preferred baseline approach, only MOSFET operating in Single Event Burnout free condition shall be authorized.

In order to prevent permanent damage, bias requirement is as follow:

For N-Channel Power MOSFETs from International Rectifier, design requirements are as follow:
VDS ? 50 % BVDSS @ BVDSS ? 200 Volts

For VDS above 50% or BVDSS > 200 Volts (for IR parts) or other manufacturers, Heavy Ions data will be provided in order to demonstrate that the application is inside the SEB safe operating area of the part.

On top of the above the ECSS-Q-ST-30-11 requirement para. 6.29 applies.

POWER MOSFET P-CHANNEL and BIPOLAR POWER transistors are SEB free.

As a preferred baseline, only MOSFET SEGR free shall be used.

For Power MOSFETs from International Rectifier, design requirements are as follow :

N Channel : VG ? 0 Volt & P Channel : VG ? 0 Volt in OFF condition
Single Event Gate Rupture sensitive parts could be used upon a case by case basis.

MS-PA-REQ-3240

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1300

As a preferred baseline approach, only Single Event Latchup Free parts shall be used.

If it may be inevitable by performance requirements to use latch-up sensitive components, user shall demonstrate, taking into account the Latch-up figure of the device, to have implemented suitable device countermeasures (e.g. adequate fast current sensing and limiting) and the rate of such events is so low than it will not affect the availability of the unit.

The following statistical approach could be proposed for not critical application only and whenever countermeasures implementation is not feasible.

Parts sensitive to Destructive Single Event Effects (Latchup, Gate Rupture, Burnout, ...) may be used, after the following analysis process :

Step 1 :

- To perform a heavy ion testing in order to get the accurate device cross section vs LET_{eq} characterization curve.
- Tests will be performed at the application bias conditions (no interpolation)
- The LET_{th} is the last point for which no destructive event is observed.

Step 2 : Calculate Destructive Single Event equivalent Rate λ_{eq} , taking into account experimental device cross section vs LET curve.

$$\lambda_{eq} \leq \frac{\lambda}{10}$$

Step 3 : The Destructive Single Event device application will be accepted only if :
where λ is the reliability failure rate of the part (@ 25°C).

$$\lambda_{eq} > \frac{\lambda}{10}$$

Step 4 : if : $\lambda_{eq} > \frac{\lambda}{10}$, then the Destructive Single Event device application will be accepted only if there is no impact on the equipment and/or system reliability analysis.

The results of this analysis will be included in the radiation analysis and submitted to prime and customer approval via RFD/RFW .

7.4.2.3 RADIATION REVIEW

MS-PA-REQ-3250

Verification:

Traces:

For coordinated procured items, the user shall co-operate with EXO-PCB in the validation of TD and SEE existing data and the agreed data or testing activities on the procured lot, if any, shall be reported in the PAD of the relevant sensitive part.

MS-PA-REQ-3260

Verification:

Traces:

For CPPA procured items, test report mentioned in the PAD as valid data for TD and SEE sensitivity shall be made available to the users/subcontractors.

MS-PA-REQ-3270

Verification:

Traces:

As well as the RVT reports shall be delivered to users. In case of drift/failures/anomalies occurring during RVT, SEE test, TD characterization test, major NCR shall be issued. Users approval of any NRB dispositions is in this case mandatory.

MS-PA-REQ-3280

Verification:

Traces:

In case of consistent self-procurement, user shall organize a radiation review at Preliminary Design Review time frame (PDR) in order to address the following points:

- To review total dose test reports, in order to validate the subcontractor radiation database. These data will be used for equipment circuit WCA.
- To determine part types that shall be submitted to a characterization and/or a RVT, selected parameters to be measured and to review radiation test plan for such parts.
- To review proposed packaging design approach to achieve maximum inherent shielding · To review preliminary shielding analysis.
- To review preliminary circuit design analysis.
- To review SEU parts data, in order to validate the subcontractor radiation database. These data will be used for equipment SEU effects analysis.
- To determine part types that shall be submitted to a Single Event Upset testing, and to review radiation test plan for such parts.

MS-PA-REQ-3290

Verification:

Traces:

In any case, the SEE criticality analysis (SEECA) shall be completed for review and approval before equipment CDR and included in the Radiation analysis. Subcontractor shall be available to organise and support adequately a dedicated SEECA review meeting on prime request in order to:

- To review circuit SEU effects analysis.
- To review the assessment on displacement damage on electronics if significant.
- To verify that no impact due to SEE on performance, undetected error rate, reliability and availability requirement
- To verify the SEECA assessment on critical FPGA and ASIC.

7.4.3 Component Derating

Deleted PA-SY-1320

Deleted PA-SY-1330

Note: These requirements are covered by para. 5.4.8

7.4.4 EEE Components Approval

MS-PA-REQ-3300

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1340

The EXO-PCB has the task to review any equipment DCL and to approve any candidate for co-ordinated procurement taking into account the suitability of the selected component to the EXOMARS requirements (quality level, operative temperature range, lifetime, radiation tolerance, etc.) and standardisation related issues (procurement channel/not recurring effort/high MOQ).

MS-PA-REQ-3310

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1380

Any component shall be approved for FM use through Part Approval Document (PAD) prepared by the procurement authority according to the following scheme:

- Components approved for co-ordinated procurement shall be formally covered by PAD, prepared by CPPA and submitted to TAS/ESA approval in the frame of EXO-PCB. CPPA shall gather the customer PAD approval before starting the procurement of the relevant part. Users of CPPA service will not need to raise PADs for co-ordinated procured items.
- Each "Self Procured" and/or "Self Manufactured" component (i.e. component that will be procured/manufactured directly by the users) shall be approved via PAD prepared by the user and submitted to the upper level contractor chain up to TAS and ESA approval. Components that will not be included in the loop of co-ordinated procurement need TAS /ESA authorisation before starting the self-procurement activities even if they meet the quality EXOMARS requirements.

MS-PA-REQ-3320

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1350

The previous use or approval of a part (via PAD or DCL approval) for previous ESA project shall not be considered as an automatic approval for EXOMARS. It shall be considered and traced in any case in the section "APPROVAL STATUS" of the relevant PAD.

MS-PA-REQ-3330

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1370

In case of consistent self-procurement activities, users are requested to organize dedicated PCB at their premises at the early stage of the project in order to have all parts approved by TAS-I and ESA prior the equipment CDR/EQSR close-out and prior to start the manufacturing activities.

MS-PA-REQ-3340

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1360

Users are considered fully responsible of parts selection, application and procurement (in case of self-items) even after PAD's approval.

The PAD format applicable to EXOMARS is reported into ECSS-Q-ST-60C annex A with the following modification:

Planetary protection compatibility section shall be added below the Radiation assurance section with the following fields:

- compatibility to Dry Heat sterilization process (Y/N)
 - temperature and time condition
- compatibility to Alcohol cleaning (Y/N)
- compatibility to Damp swap assays (Y/N)

7.4.5 EEE component procurement specification**MS-PA-REQ-3350**

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1390

All components intended for use in deliverable flight hardware shall be procured according to a controlled specification as described in ECSS-Q-ST-60 paragraph 5.3..

For specific EEE Parts (Asics, Procured Hybrids, transformers etc.) not covered by an existing Agency specification or for parts having specific requirements, the procurement authority (that is the CPPA for co-ordinated parts or users for authorized self-procured parts) shall issue configured procurement

specification based on ESCC or MIL documents structure for High Reliability parts, submitted to customer/TAS-I/ESA approval through the relevant PAD.

PA-SY-1400 Deleted

PA-SY-1410 Deleted

MS-PA-REQ-3360

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1570

As far as ASIC are concerned, Alterate Item Drawings (AID) based on US MIL system and ASIC sheets based on the EQML system [REP006] are considered acceptable for ExoMars and shall be provided to the contractual customer up to prime and ESA together with the relevant PAD sheets.

All encapsulated high reliability parts shall be procured preferably directly from EEE parts manufacturers.

7.4.6 Quality Level

MS-PA-REQ-3370

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1420

EEE parts screening level shall be in accordance with ECSS-Q-ST-60, paragraph 5.3.3 and table 7-2, with the exception that commercial parts are not applicable as not allowed in Exomars.

For hybrids the ECSS-Q-ST-60-05 testing level 1 or MIL-PRF-38534 class K shall apply.

For optocoupler procured in accordance to MIL-PRF-19500, JANS screening applies.

MS-PA-REQ-3380

Verification:

Traces:

The following documents can be used as applicable:

ECSS-Q-ST-60-05 testing level 1 may be applied for hybrids if ESCC has classified the relevant manufacturer as Category 1 for the technology domain relevant to a particular Hybrid circuit

ECSS-Q-ST-60-12C is applicable for all activities up to acceptable dice level MMICs

For hybrids according to PSS or manufactured in Europe all add-on components shall be listed and traced in the relevant procurement specification.

MS-PA-REQ-3390

Verification:

Traces:

For US hybrids whose DCLs are not disclosed cause considered proprietary/reserved information, the procurement authority shall propose alternative mean indicated in the relevant PAD in order to reach the necessary confidence on quality of add-on parts, traceability, radiation assurance.

MS-PA-REQ-3400

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1440

Any additional and/or alternative screening proposals may be applied for procurement only upon approval of the relevant PAD as required in ECSS-Q-ST-60 .
In case of need of components available on the market only in a lower screening level, up-screening will be planned and the flow of activities provided and approved via life-cycle of the relevant PAD.
The up-screening activities will be preferably performed by the manufacturer its-self.

7.4.6.1 Additional tests

MS-PA-REQ-3410

Verification:

Traces:

In addition to the above specified screening level, the following additional tests shall apply:

MS-PA-REQ-3430

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1500

- Parts with cavities shall be subjected to PIND test on a 100% basis
-

MS-PA-REQ-3440

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1510

- All solid tantalum capacitors shall be subjected to surge current testing as per the relevant specification.
-

MS-PA-REQ-3450

Verification:

Traces:

- EEPROM procurement specification shall specify the data retention time guaranteed over the full operating temperature range. This specification shall detail all the tests performed at die revision level, part level and lot level, in order to guarantee this data retention time

MS-PA-REQ-3460

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1520

- PRECAP inspection shall be performed as defined in the table 1 that describes the pre and post procurement inspections per family/specification applicable to Exomars mission.

MS-PA-REQ-3470

Verification:

Traces:

- If a PRECAP inspection is not possible for the purchased quality level, an extended DPA shall be performed and described in the relevant PAD.

MS-PA-REQ-3480

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1530

- DPA requirements shall be implemented as found in ECSS-Q-ST-60 [NR 089], paragraph 4.3.9 with the modifications of paragraph 4.3.9/b detailed in table 1. The DPA shall be performed on three pieces per lot; any deviation on the above rule shall be agreed via PAD approval process

MS-PA-REQ-3490

Verification:

Traces:

Post programming conditioning sequence in user programmable devices, like anti-fuse technology PROM, shall be specified and approved on a case by case basis in the relevant PAD: in case of coordinated procurement user shall produce post programming conditioning flow to EXO-PCB for review and approval.

7.4.6.2 HYBRIDS

MS-PA-REQ-3500

Verification:

Traces:

Hybrids shall be manufactured in a validated hybrid line , qualified and screened in accordance with ESA/PSS-01-608 level B or MIL-PRF-38534 Class K or ECSS Q-ST-60-05 or alternative document approved by TAS/ESA .

The qualification of the die mounting shall be performed by the hybrid manufacturer in order to validate and demonstrate the compatibility between the micro component and the hybrid manufacturer processes.

Complementary qualification shall be performed whenever micro component definition (design, processes, mask) has changed.

Each micro component (Active or Passive) lot shall undergo a User Lot Acceptance Test or element evaluation in accordance with ESA/PSS-01-608 level B or MIL-PRF-38534 Class K or ECSS-Q-ST-60-05 or alternative document approved by TAS/ESA.

7.4.6.3 MMICs

MS-PA-REQ-3510

Verification:

Traces:

The design, development, manufacturing and testing of custom MMICs will follow the ECSS-Q-ST-60-12C, MMIC in chip form to be used in hybrids.

In case of new development, the procurement of working samples shall be considered in order to allow users/experimenters to verify at least the suitability of the performances before starting the evaluation/qualification flow.

7.4.6.4 ASIC/FPGA

MS-PA-REQ-3520

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1550

The development, prototyping, manufacturing, testing and validation of custom ASIC or FPGA for ExoMars shall follow the rules of ECSS-Q-ST-60-02.

MS-PA-REQ-3530

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1590

Users shall present to TAS/ESA approval the trade off between ASIC and FPGA: the decision shall be taken on a case by case basis evaluating the criticality and the peculiarity of each application in the frame of SRR of the relevant unit.

The development of any new ASIC or FPGA shall be considered a critical item and thus its development shall be followed by tracking it in the user CIL.

The FPGA/ASIC reviews (both public and internal) as required in the ECSS-Q-ST-60-02 shall be thoroughly planned and reported in the general schedule of the relevant unit.

For any ASIC/FPGA design developed in the frame of the project , the user (and developer) is required to make public the following reviews:

- Preliminary Design Review (PDR) shall be organised as described in ECSS-Q-ST-60-02. Explicit TAS/ESA approval needs to be obtained to proceed further from the PDR of the ASIC or FPGA
- Qualification Review/Acceptance review (QR/AR) shall be organised as required in ECSS-Q-ST-60-02: this review shall result in the final acceptance of the design and release for FM production concluding the design validation. At the end of this review the FPGA specification or Altered Item Drawing shall be frozen. Explicit TAS/ESA approval needs to be obtained.

MS-PA-REQ-3540

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1560

In any case TAS and ESA reserve the right of access to all ASIC/FPGA documentation file as required by ECSS-Q-ST-60-02.

MS-PA-REQ-3550

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1600

For testing, verification, trouble shooting and failure analysis, each FPGA user is requested to realize and keep under configuration control test interface boards and relevant test software and equipment and test procedures which allow all functional and parametric tests to be performed on every programmed part independently from the actual unit where it is intended to be used.

All programmed FPGAs shall receive a dynamic post programming burn in and testing sequence according to manufacturer's specifications and approved by EXO-PCB.

7.4.6.5 In House Manufactured Parts

MS-PA-REQ-3560

Verification:

Traces:

All EEE parts manufactured by users (e.g. coils and transformers) in accordance with internal process procedures will be documented through specifications / source control drawings and approved via PAD submission to EXO-PCB.

MS-PA-REQ-3570

Verification:

Traces:

Minimum screening requirements will be those of the nearest applicable ESCC or space level MIL specification; for other in-house parts the screening sequence and the lot acceptance will be defined in relevant PAD.

MS-PA-REQ-3580

Verification:

Traces:

For electromagnetic parts, minimum screening on a 100% sampling basis in accordance to MIL-STD-981 shall be:

- visual inspection,
- electrical measurements before test,
- thermal cycling ,
- high temperature storage (minimum 96 H) (optional)
- final electrical measurements

MS-PA-REQ-3590

Verification:

Traces:

Table 1 - Minimum Screening and Inspection Requirements

(--) = Not Applicable

(X) = Required for non standard parts (see applicable note)

(XX) = Systematically Required for Non Qualified and Qualified Parts

			CSI and DPA requirements			
Ref. Part Family	Applicable Screening Requirements Note 1	Note	Precap Note 2	Final Notes 2, 3	DPA Note 4 Note 23	Number of unit (Note)
1. Diodes (Low Frequency)	ESCC 5000	11	—	—	X	3 (18)
	MIL-PRF-19500- JANTXV + PIND (where applicable)					
2. Diodes (High Frequency)	ESCC 5010 Level C + PIND (where applicable)	—	—	—	X	3 (18)
	MIL- PRF -19500- JANTXV + PIND (where applicable)					
3. Transistors (Low Frequency)	ESCC 5000	—	—	—	X	3 (18)
	MIL- PRF -19500- JANTXV + PIND (where applicable)					
4. Transistors HF (Bipolar - GaAs)	ESCC 5010 level C + PIND (where applicable)	12	—	—	X	3 (18)
	MIL- PRF -19500- JANTXV + PIND (where applicable)					
5. Monolithic Microwave integrated Circuits (MMICs) (procured items, packaged devices)	ESCC 9010 Level C + PIND (where applicable)	14	—	—	XX	3 (18)
	MIL-PRF-38535, QML Q + PIND (where applicable)					
6. Integrated Circuits, ASICs, and Memories (Except One time programmable types)	ESCC 9000	13 +13 A	—	—	X	3 (18)
	MIL-PRF-38535 QML Q + PIND (where applicable)					
7. FPGA and Memories (One time Programmable)	ESCC 9000	(PPBI) 24 Subgro up 2	—	—	X	3 (18)
	MIL-PRF-38535, QML Q + PIND (where applicable)	(PPBI) 24				
8. Opto Couplers	ESCC 5000 MIL-PRF-19500 JANS MIL-PRF-38534 Class K	—	XX	XX	XX	3 (18)
9. Capacitors Fixed Ceramic Dielectric Molded	ESCC 3001 Level C	—	—	—	X	3x3 (17)
	MIL-PRF-123 FRL R MIL-PRF-20 FRL R MIL-PRF-39014 FRL R	21	—	—	X	

			CSI and DPA requirements			
Ref. Part Family	Applicable Screening Requirements Note 1	Note	Precap Note 2	Final Notes 2, 3	DPA Note 4 Note 23	Number of unit (Note)
10. Capacitors Fixed Ceramic Dielectric Chips	ESCC 3009 Level C	—	—	—	X	3x3 (17)
	MIL-PRF-123 FRLR MIL-PRF-55681 FRL R	21	—	—	X	
11. Capacitors fixed ceramic dielectric, stacked	ESCC 3009 Level C	—	—	—	X	3x3 (17)
	MIL-PRF-49470- level T	21	—	—	XX	3 (18)
12.Capacitors Fixed Electrolyte (Solid electrolyte) Tantalum	ESCC 3002 Level C	6a	—	—	XX	3 (18)
	MIL-PRF-39003 Weibull C					
13.Capacitors Fixed Electrolyte (nonsolid electrolyte) Tantalum	ESCC 3003 Level C	—	—	—	XX	3 (18)
	Use only MIL-PRF-39006 /22,25,30,31 "H" designated devices Weibull C					
14.Capacitors Chips Fixed Tantalum	ESCC 3011 Level C ESCC 3012 Level C	6b	—	—	XX	3 (18)
	MIL-PRF-55365 Weibull C					
15.Capacitors Variable (piston type and tubular trimmer)- Avoid for New Design	ESCC 3010 Level C	7	—	—	—	—
	No MIL spec applicable					
16.Capacitors Fixed Glass Dielectric	ESCC 3004 Level C	5	—	—	—	—
	MIL-PRF-23269 FRL R					
17.Capacitors Fixed MICA Dielectric	ESCC 3007 Level C	—	—	—	X	3X3 (17)
	MIL-PRF-87164 FRL R					
18.Capacitors Fixed metallized plastic film Dielectric style CRH (ac and dc current)	ESCC 3006 Level C	—	—	—	X	3X3 (17)
	MIL-PRF-83421 FRL R					
19.Capacitors Fixed Super metallized plastic film Dielectric style CHS (dc current for low energy, high impedance)	ESCC 3006 Level C	—	—	—	X	3X3 (17)
20.Capacitors Fixed Plastic or paper dielectric style CQR (direct current)	ESCC 3006 Level C	—	—	—	X	3X3 (17)
	MIL-PRF-19978 FRL.R					

			CSI and DPA requirements			
Ref. Part Family	Applicable Screening Requirements Note 1	Note	Precap Note 2	Final Notes 2, 3	DPA Note 4 Note 23	Number of unit (Note)
21.Resistors Fixed wire-wound accurate (RBR type)	ESCC 4002 Level C MIL-PRF-39005 FRL R	—	—	—	—	—
22.Resistors Fixed wire-wound power type (RWR type)	ESCC 4002 Level C MIL-PRF-39007 FRL R	—	—	—	—	—
23.Resistors Fixed Wire-wound power type chassis mounted (RER type)	ESCC 4003 Level C MIL-PRF-39009 FRL R	—	—	—	—	—
24.Resistors Fixed Film insulated (RLR type)	ESCC 4001 Level C MIL-PRF-39017 FRL R	—	—	—	—	—
25.Resistors Fixed high precision film (RNC type except RNC 90)	ESCC 4001 Level C MIL-PRF-55182 FRL R	—	—	—	—	—
26.Resistors Fixed high precision film (RNC 90 type)	ESCC 4001 Level C MIL-PRF-55182/9 FRL R	—	—	—	X	3X3 (17)
27.Resistors TC precision high voltage	ESCC 4001 Level C GSFC - S311-P-XXX	—	—	—	—	—
28.Resistors network thick films	ESCC 4005 Level C MIL-PRF-83401 M part number level	—	—	—	X	3X3 (17)
29.Resistors Fixed thick-film chips - Fixed thin - film chips	ESCC 4001 Level C MIL-PRF-55342 FRL R	—	—	—	— XX	— 3X3 (17)
30.Thermistors (thermally sensitive resistors)	ESCC 4006 Level B MIL-PRF-23648 GSFC-S-311-P18	8	—	—	—	—
31.Coils fixed molded	ESCC 3201 Level C MIL-PRF-39010 MIL-STD-981 Eq Class S	—	—	—	X	3 (18)
32.Coils fixed Non molded	ESCC 3201 Level C MIL-STD-981 Eq Class S	—	—	—	—	—

			CSI and DPA requirements			
Ref. Part Family	Applicable Screening Requirements Note 1	Note	Precap Note 2	Final Notes 2, 3	DPA Note 4 Note 23	Number of unit (Note)
33.EMI filters	ESCC 3008 Level C	—	—	—	X	3 (18)
	MIL-PRF-28861 Class B					
34.Crystal units, quartz	ESCC 3501 Level B	15	XX	XX	XX	1 (18)
	MIL-PRF-3098 Class S					
35.RELAYS Electromagnetic (latching and non latching relays)	ESCC 3601 Level B	16	XX	XX	XX	3 (18)
	ESCC 3602 Level B					
	MIL-PRF-39016 + SCD corresponding to FRL S	16 + 22				
36.Connectors, RF coaxial	ESCC 3402 Level B	—	—	—	—	—
	MIL-PRF-39012 + Out-gassing Spec Amendment					
37.Connectors, electrical circular and rectangular	ESCC 3401 Level B	—	—	—	—	—
	MIL-DTL-24308 - Class M (rectangular)					
	MIL-DTL-38999 - Classes G and H (circular)					
	MIL-PRF-83513 - Class M					
38.Connectors, electrical-RF filters	ESCC 3401 Level B	—	—	—	—	1 (18)
	ESCC 3405 Level B					
	MIL-DTL-24308 - Class M					
39.FUSES (miniature insulated case)	ESCC 4008 Level C	9	—	—	XX	3 (18)
	MIL-PRF-23419					
40.FUSISTORS	ESCC 4008 Level C	10	—	—	X	3 (18)
41.Heaters	ESCC 4009 Level C	—	—	—	—	—
42.Thermostat (Switches Thermostatic)	ESCC 3702 Level B	20	XX	—	XX	3 (18)
	MIL PRF-24236 FRL S					
43.Switches Mechanical (non RF) sensitive and push snap action	ESCC 3701 Level B	—	XX	—	XX	3 (18)
	MIL-PRF-8805 FRL S					

			CSI and DPA requirements			
Ref. Part Family	Applicable Screening Requirements Note 1	Note	Precap Note 2	Final Notes 2, 3	DPA Note 4 Note 23	Number of unit (Note)
44. Microwave passive parts (isolators and power divider coupler coaxial)	ESCC 3202 Level B ESCC 3404 Level B	—	—	—	—	—
	MIL-PRF-23971					
45. Microwave passive parts (attenuators and loads)	ESCC 3403 Level C	—	—	X	—	—
	MIL-DTL-3933 Attenuators S Part number level					
	MIL-PRF-39030 loads S Part number level					
46. Surface Acoustic waves filters (SAW)	ESCC 3502 Level B	—	X	X	X	1 (18)
47. Transformers molded	ESCC 3201 Level C	—	—	—	X	3 (18)
	MIL-STD-981 Eq Class S SSQ 22676 Rev C					
47Bis . Transformers Non molded	ESCC 3201 Level C	—	—	—	—	—
	MIL-STD-981 Eq Class S SSQ 22676 Rev C					
48. Procured hybrids	ESA/PSS-01-608 Level B ECSS-Q60-05A	—	XX	XX	XX	1 (18)
	MIL-PRF-38534, Class K					
49. Oscillator Controlled	MIL-PRF-55310 Class S	—	XX	XX	XX	1 (18)
50. Cables - Wires Low Frequency	ESCC 3901 Level B	19	—	—	—	—
	MIL-W-22759 MIL-DTL-27500					
51. Coaxial Cables	ESCC 3902 Level B	19	—	—	—	—
	MIL-DTL-17					

NOTES

1. Minimum screening requirements may be used as guidelines, variations implemented by high reliability manufacturers and documented, are allowed pending a PAD approval.

2. For qualified Military class level B parts, class Q parts, class K parts, JAN TXV parts, QPL listed ER MIL passive parts, QPL listed Military specifications passive parts and ESCC qualified parts, as defined in table 1 including the required quality level, the customer source inspections (precap and final source inspections) are not required.

The exceptions are identified by XX in table 1.

3. Final source inspection of delivery lots will be conducted before shipment to ensure conformance with requirements of the POs, procurement specification(s) and data requirements. This source inspection shall include final acceptance test witnessing as required. It may be replaced by incoming inspection under EXO-PCB approval.

4.DPA shall not be required for qualified Military class level B parts, class Q parts, class K parts, JANTXV parts, QPL listed ER MIL passive parts, QPL listed Military specifications passive parts and ESCC qualified parts, as defined in table 1 including the required quality level.

The exceptions are identified by XX in Table 1).

5.Applicable for styles CYR51, 52 and 53 only

6.a) For parts family 12: Capacitors Fixed Electrolyte (Solid Electrolyte) Tantalum: 100 % Surge Current screening shall be performed in accordance with MIL-PRF-39003/10B as defined in Group A inspection.

b) For parts family 14: Capacitors Chips Fixed Tantalum.

100 % Surge Current screening shall be performed for all surface mounted tantalum capacitors types in accordance with MIL-PRF-55365 issue F, § 1.2.1.

- Stock parts procured with surge current test option A, no additional test is required
- Stock parts procured with no surge current test, 100% surge current test option B is required
- For new procurement, 100% surge current test, option B or option C is required

Or, 100 % Surge Current screening shall be performed for all surface mounted tantalum capacitors types in accordance with ESCC 3002, § 9.22

- Burn-in for variable capacitors is not required. Temperature cycling, vibration (only on air dielectric types) and driving torque will be performed on a 100 % basis with critical parameters verified. Air variable capacitors shall be internally inspected, cleaned and lubricated in lieu of radiographic inspection and destructive physical analysis (DPA). Parameter drift screening applies only to air dielectric type variable capacitors from pre-to post-vibration.

8.168 hours burn in on PTC thermistors is performed at maximum power rating of part and on NTC thermistors the test is non-operating (storage).

9. Wire link fuses are forbidden. Only ceramic fuses are allowed..

10.Fusistors shall be burned-in at 50% of the current rating of part for 168 hours minimum.

11.Diodes procured to Source Control Specifications that are rated at greater than 1 Amp of current or 1 Watt of power shall be considered as power diodes. In this case, the 100 % screening sequence shall include a thermal impedance test based thermal transient method of MIL-STD-750 test method 3101 and a sample surge current test shall also be imposed.

12.MIL-PRF-19500 JANTXV + PIND and ESCC 5010 level C +PIND screening are used as a guideline, variations may be used by high reliability manufacturers provided they are approved and documented.

Proposed screening shall be agreed during the PAD/NSPAR approval process.

- ASIC - Additional qualification Conformance Testing or lot Acceptance Testing (LAT) may be required for parts of these type categories as defined in the relevant PAD.

13A. For EEPROMs: The procurement specification shall specify the data retention time guaranteed over the full operating temperature range. This specification shall detail all the tests performed at die revision level, part level and lot level, in order to guarantee this data retention time.

- For MMIC procured items packaged devices ESCC 9010 level C + PIND or MIL-PRF-38535 Q + PIND may be used as a guideline. Proposed deviations shall be agreed during the PAD/NSPAR approval process.

15.For crystals units, the raw materials must be cultured premium Q swept for high stability application.

For crystals units, the temperature and duration of the aging test shall be adequate to demonstrate and document that the frequency stability of the crystal meets the program life requirements. The demonstration of the frequency stability of the crystal may be documented by the use of an equation of the form $f(t) = A (\ln(Bt+1)) + f_0$.

Where $f(t)$ is the frequency of the crystal unit t days after the start of the aging cycle, and A , B and f_0 are constants to be determined from the least square fit. The calculated frequency f_0 is the beginning of the aging cycle.

- Lot acceptance testing (life test) shall be performed on non-qualified relays to show that the devices pass a minimum of 100 000 cycles 125°C operational test at the maximum rated voltage and current.

17. -3 values (lowest-middle-highest values) by lot/date code or periodically in order to verify processes stability.

- By lot/date code.

19. If the silver thickness is less than 2 μm a corrosion test shall be performed to determine the suitability of silver plated wire/cable materials. Proposed test shall be agreed during the PAD/NSPAR approval process.

20.- Thermostats procured in accordance with MIL-PRF-24236 shall be considered as non qualified parts. In this case, PAD/NSPAR and CSI shall be mandatory.

- For each purchase order the primary elements shall be from the same manufacturing lot and only one sealing lot shall be required.

- Endurance test 100.000 cycles with voltage/current conditions covering the application shall be performed on non qualified thermostats. The endurance test 100.000 cycles shall be performed with voltage /current conditions covering the application on 6 sample units.

In this case, DPA shall be only performed after endurance test on 3 sample units out of the 6 sample units.

- Multi-layer Ceramic Capacitors procured with MIL-PRF Spec shall be submitted to QCI testing including Steady State Low Voltage Test according to MIL-PRF-123 , Group B, Subgroup 2 (85Rh/85°C)

22.Procurement of relays (in particular TO5 Types) according to MIL-PRF-39016 only is not allowed. For Latching and Non Latching Types , a spec Amendment shall include : Millipore Cleaning, Random Vibration , 2500 Miss-Test Cycles. In addition, for Latching types ,100% neutral screening test is required.

23.For items judged critical (no previous heritage, unknown manufacturer, recent documented DPA failure) an increase of DPA samples could be requested by EXO-PCB and traced in the relevant PAD

24.Applicable flow for Antifuse based FPGA

	N°	TEST	CONDITIONS	SAMPLING PLAN	REMARKS
Sub grp 1	1	Serialization		100%	Note A
	2	External Visual Inspection	MIL-STD-883 method 2009	100%	Note C
	3	Temperature Cycling	MIL-STD-883 method 1010 test condition C	100%	Note A and Note C
	4	PIND Test	MIL-STD-883 method 2020 cond. A	100%	Note A and Note C
	5	Radiographic	MIL-STD-883 method 2012	100%	Note A and Note C
Sub grp 2	6	Seal, Fine and Gross	MIL-STD-883 method 1014	100%	Note A and Note C
	8	Virginity Test		100%	if applicable
	9	Programming		100%	Note B
	10	Checksum Control		100%	
	11	Electrical Measurements, static and functional	Ta = +25°C	100%	Read and Record
			Ta = -55°C, +125°C	100%	Go-no-Go
	12	Burn-In	Ta = +125°C, 168h min	100%	Dynamic condition by means of proper test vectors (dynamic bias for FPGA with activated clocks and activated logic and sequential chains)
	13	Electrical Measurements, static and functional	Ta = +25°C	100%	Read and Record
	14	Drift calculation	(@ +25°C)	100%	
	15	Electrical Measurements, static and functional	Ta = -55°C and +125°C	100%	Go-no-Go
	16	Percentage Defective calculation	Rejects on tests 13 and 14, PDA = 5% (*)	Whole lot	(*) Rounded upwards to the nearest whole number
	17	External Visual Inspection	MIL-STD-883 method 2009	100%	Note C

Note A : Not to be performed if already performed by the manufacturer during initial screening

Note B : Only one programming run is allowed for each part

Note C: Use of an alternate procedure is allowed pending prior approval from TAS/ESA

7.4.7 LAT/QCI

MS-PA-REQ-3600

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1430

Exomars LAT requirements are found in ECSS-Q-ST-60 [NR 089], paragraph 5.3.5 with the modifications identified in the following paragraphs. The ECSS-Q-ST-60 [NR 089] requirements for Lot Acceptance on commercial parts are not applicable as these parts are not allowed in Exomars.

MS-PA-REQ-3610

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1440

For the definition of LAT requirements, the ECSS-Q-ST-60 [NR 17] wordings 'space qualified' shall be interpreted in Exomars as follows.

For European components, such references are equivalent to the listing in the ESCC QPL. For US components, such reference is restricted to Class Q/M items in MIL-QML-38535 [NR 68], Class K items in MIL-QML-38534 [NR 67], JANS optocouplers in MIL-QML-19500, JANTXV items in MIL-QML-19500 [NR 66] and Established Reliability R items in other QPLs as long as type and value are listed in NPSL.

MS-PA-REQ-3620

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1480

The LAT2 on European parts not listed in ESCC QPL may be waived if 1) and 2) below are verified:

1. In cases where design, construction or process changes have not taken place compared to previous procurements
2. And only if LAT2 successful results have been obtained during the 24 months prior to the expected date code.

However, LAT2 shall be implemented for certain families, as follows, regardless the history of the manufacturing line or previous LATs:

1. LAT2 per assembly date code is required on non-qualified chip solid Tantalum capacitors, crystals, fuses, relays, thermostats.
2. LAT2 per wafer lot is required on non qualified microwave diodes, integrated circuits (F4 subgroups 2 and 3 per ESCC9000 [NR 69]), MMICs and microwave transistors.

MS-PA-REQ-3640

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1460

For MIL systems, the following paragraph applies.

Regarding non- 'space qualified' components of US origin, Quality Conformance Inspection (QI) and Periodic Inspection (PI) shall be implemented as required by the relevant MIL generic specification. The sample sizes can be reduced for expensive components. Such relaxation shall be agreed in the relevant PAD.

QCI generic data shall be requested in case of critical procurement of components listed in QML (e.g failure in recent procured lot, unknown manufacturer).

MS-PA-REQ-3650

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1460, EXM-MS-RS-ESA-00002#PA-SY-1480

For hybrids both new design and recurrent, the procurement will include LAT as per PSS-01-608 or ECSS-Q-ST-60-05 if applicable to the hybrid manufacturer.

For OTS hybrids listed in QML-38534, QCI group C2 (steady state life test) will be performed on the procured batch. Reduction of sample size will be agreed via PAD on case by case basis.

MS-PA-REQ-3660

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1470

New design ASIC from non-qualified sources will be subjected to chart F4 of ESCC 9000.

7.4.8 Long Lead Items

MS-PA-REQ-3670

Verification:

Traces:

Long lead parts shall be identified early in the program in order that procurement can proceed to meet the program schedule.

A part shall be considered long lead if:

- The time between the date of purchase order to the manufacturer or to the procurement agent and the delivery is greater than 52 weeks.
- Parts that have an anticipated delivery date exceeding the earliest User need date.
- Parts submitted to export regulation restriction from the US Department of Defense
- Parts available from a unique manufacturer (e.g. rad-hard MOSFETs)
- New design ASICs, MMIC and hybrids
- New technologies that shall be submitted to qualification

In case of serious schedule concern for long lead items (e.g. LAT failure, schedule slips, qualification problems) a backup procurement must be initiated.

The obsolescence risk shall be kept under control: when components are selected and approved for project application, their availability throughout the project lifetime shall be assessed by the procurement authority and when an availability risk is expected, a backup solution shall be identified.

Subcontractors shall provide to TAS a Long Lead Item List/status with the information relevant to the reason for long delivery, estimated delivery in weeks, need dates, date of purchase order placement as part of the progress report.

CPPA shall provide to TAS/ESA with a planning for parts procurement that shall be updated for each EXO-PCB.

7.4.9 Alert / Problem notification

MS-PA-REQ-3680

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-300

CPPA as well as users shall participate to the ESA alert system and screen alerts and problem notification as a day by day activity of the component control plan.

Any alert / problem applicable to a component listed in EXO Master Part List shall be notified immediately by the CPPA to the users and to EXO-PCB. The CPPA is responsible to provide with the user/ EXO-PCB any details available of the problem and of the range of components affected (indicating Alert number, generic part type, manufacturer, plant, Lot/Date code, summary of the problem, recommendations). The user shall perform an alert assessment taking into account their application boundary.

For self-procured components, the user is responsible to perform the tasks above described.

MS-PA-REQ-3690

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-320

CCPA and users, is responsible to maintain an Alert status list tracking applicability and corrective actions (if any) as requested in para 4.7

7.4.10 Attrition

MS-PA-REQ-3700

Verification:

Traces:

Additional parts for manufacturing attrition shall be calculated and ordered by users to CPPA for co-ordinated procured items, or procured directly by users for self-procurement). Attrition shall be calculated at unit level (or to total number in case of identical units).

MS-PA-REQ-3710

Verification:

Traces:

The attrition rules shall be declared in the users PA plan.

MS-PA-REQ-3720

Verification:

Traces:

At the time being, the following table can be taken as reference:

1 to 5	3 samples
6 to 10	4 samples
11 to 30	6 samples
31 to 50	8 samples
51 to 100	12 samples
> 100	15%

MS-PA-REQ-3730

Verification:

Traces:

The attrition rule for one time programmable ICs shall be twice of the standard attrition quantities (see above). It should be noted that user may be requested to increase the attrition on a case by case basis in order to cover also multiple redesigns (e.g. PROM used for storing boot software).

MS-PA-REQ-3740

Verification:

Traces:

For highly expensive integrated circuits (like FPGA, microprocessors, memories) or for unique devices (like customised items, connectors bodies, heaters, etc.) a reduction of attrition or a CPPA centralised attrition stock may be proposed to EXO-PCB acceptance.

MS-PA-REQ-3750

Verification:

Traces:

The users shall define separately in the DCL the two quantities:

- Engineering quantity
 - Attrition quantity
-

7.4.11 Traceability

MS-PA-REQ-3760

Verification:

Traces:

Traceability shall be maintained from serialized part to assembly level.

MS-PA-REQ-3770

Verification:

Traces:

Traceability during EEE parts manufacturing and testing shall be covered by the procurement specifications and the applicable system (ESCC or MIL).

MS-PA-REQ-3780

Verification:

Traces:

Such traceability shall be kept by the procurement responsible and any later EEE parts user during storage / handling.

MS-PA-REQ-3790

Verification:

Traces:

Traceability of EEE parts during installation in unit, shall be ensured by the Subcontractor to provide the traceability of the actually mounted components (manufacturer lot / Date Code number) . This shall be reflected in an "as built DCL" parts list.

7.5 Quality Assurance & EEE Parts NCR

7.5.1 Manufacturer and part evaluation

MS-PA-REQ-3800

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1610

Users for authorized self-procurement shall ensure that the parts are procured from the selected manufacturer and in compliance with the requirements defined in this document.

In case that a valid and acceptable qualification cannot be demonstrated, a Part Evaluation program in conformance with requirements of Class 2 parts in ECSS-Q-ST-60 shall be implemented. The content and extent of such a program requires approval of EXO-PCB.

The results of the test, audit, analysis performed in the frame of the evaluation programme shall be collected in an evaluation report submitted to EXO-PCB review and approval in case the evaluation has been conducted by CPPA in the frame of co-ordinated procurement.

MS-PA-REQ-3810

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1620

Users are considered anyway fully responsible of the selection and application of the parts to be evaluated and then they shall proactively co-operate with CPPA with their specific expertise in defining the evaluation program and collecting the needed information.

In case of evaluation conducted directly by the user on a self-procured item, the evaluation report shall be made available (during dedicated PCB meeting in case the document are considered proprietary) for TAS/ESA review.

Sample parts used for evaluation shall be representative of flight model parts.

7.5.1.1 Evaluation program

MS-PA-REQ-3820

Verification:

Traces:

The evaluation program shall cover the following elements:

- Constructional analysis.
- Manufacturer assessment.
- Evaluation testing.

When several part types from a single part family are considered for use, the evaluation program may be conducted on a representative sample of part types from the part family.

7.5.1.1.1 Constructional analysis

MS-PA-REQ-3830

Verification:

Traces:

Constructional analysis on parts shall be carried out. The primary aim of constructional analysis is to provide an early indication of the probability that the selected part will meet the qualification requirements and the operational goals of EXOMARS mission. It is therefore essential that:

- a) The standard of fabrication and assembly is fully assessed to identify any area where modifications are required or where specific tests or inspection points should be included within the procurement specification or during procurement.
- b) All potential failure modes are identified in order to assess the need for additional tests.
- c) Assurance is obtained that no materials or processes have been employed that are likely to deteriorate over time and cause malfunction and that they are compatible with sterilization methods.

7.5.1.1.2 Manufacturer assessment

MS-PA-REQ-3840

Verification:

Traces:

The purpose of the evaluation of a manufacturer is to assess his capability, to ensure the adequacy of his organization plant and facilities, and to ascertain his fitness to supply parts to the appropriate specifications for space application. This evaluation shall include, but not necessarily be limited to, a survey of:

- a) The overall manufacturing facility and its organization and management.
- b) The production line used for the part.
- c) The manufacturer's system for inspection and manufacturing control including all relevant specifications, procedures, and documents.

The complete manufacturer evaluation shall be included as a section of the evaluation report.

7.5.1.1.3 Evaluation testing

MS-PA-REQ-3850

Verification:

Traces:

After successful completion of the constructional analysis and manufacturer evaluation, evaluation testing shall be performed. This assessment shall determine which inspections or tests are required to provide the confidence that the part type under evaluation will, when assembled and tested in accordance with the procurement specification, successfully meet the mission requirements.

MS-PA-REQ-3860

Verification:

Traces:

Sufficient data must be available upon completion of the evaluation program to demonstrate part stability. In addition, evaluation testing shall be required where any of the previous stages have identified any anomaly reflecting a design, material, or process weakness that could shorten the active life of the concerned part and that may not be identified during the final production testing or screening tests included in the procurement specifications.

MS-PA-REQ-3870

Verification:

Traces:

Because of the wide range of possible anomalies or weaknesses that would require evaluation testing, it is not possible to define the precise test program to be followed; however, the types of testing to be considered would include:

- a. Electrical stress, such as accelerated life testing, high temperature reverse bias, or endurance testing, normally used to assess stability.
- b. Mechanical stress, including shock, vibration, and centrifuge, to evaluate the robustness of the assembly.
- c. Environmental stress, such as thermal shock or cycling, high- or low-temperature storage, and seal tests, etc., to evaluate package integrity or a particular facet of the design expected to be susceptible to temperature extremes.
- d. Radiation testing

MS-PA-REQ-3880

Verification:

Traces:

A tailoring or modification of the above reported test campaign can be performed, depending on the qualification status of the component and on the specific application condition.

MS-PA-REQ-3890

Verification:

Traces:

On a case by case basis, the evaluation campaign is reduced to specific electrical test (long duration, power/thermal cycles, electrical parameters measurement) in operating condition outside the qualified operating range. E.g. components that needs to be stored at temperature below minimum storage temperature limit or need to be bias at temperature below the minimum operating temperature limit.

MS-PA-REQ-3900

Verification:

Traces:

The proposed test program, the test methods, and sample size shall be approved as defined in the Parts Approval section of this document, before test commencement, and shall be available for review. After completion of the evaluation testing, a final review of the proposed procurement specification shall be carried out to determine if the obtained results will have an impact on the content of the procurement specification.

7.5.1.1.4 Evaluation report

MS-PA-REQ-3910

Verification:

Traces:

The full details of the evaluation testing, the results achieved, and an overall assessment of the complete evaluation program shall be included within the evaluation report, which, once complete, shall be available for TAS/ESA approval.

7.5.1.2 Radiation characterization

MS-PA-REQ-3920

Verification:

Traces:

Radiation tests shall be performed to assess the parts sensitivity for EXOMARS environment in accordance with the radiation requirements as described in para 7.4.2

7.5.2 EEE NCR

MS-PA-REQ-3930

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1630

ECSS-Q-20-09B applies. In particular paragraph 6.1 shall be read in conjunction to the following:

The NCR shall be issued by the procurement authority.

The NCR may occur either:

- at the parts manufacturer,
- during shipment,
- after receipt at CPPA,
- after receipt at the user,
- on ExoMars equipment failure due to a parts problem.

The non-conformance control shall be applied throughout the programme. Users shall apply a NCR procedure such that all the activities necessary to provide assurance that any non-conformance is

detected, identified, investigated and corrected, are completely defined. A failure analysis shall be performed as necessary to highlight the failure whenever required by the NRB and the relevant report shall be linked to the NCR.

Preventive actions shall be defined in such a way that they will minimise risk to the technical success, cost or project schedule.

Criteria for NCR classification as major or minor are included on the table below

The NCR numbering shall follow the project numbering system as defined in EXM-MS-RS-ESA-00012.para 9

MAJOR	MINOR
Functional and / or operational performance	When the failure does not affect workmanship criteria
Functional and / or dimensional interfaces and / or interchangeability	A random failure on EEE parts with no risk of reliability or quality and the form, fit and function is not affected
Form, materials, processes, weight, centre of gravity	Minor inconsistencies in the accompanying documentation
Personal health and safety	
Reliability, maintainability and durability	
Acceptance or qualification tests with the requirements	
High reliability EEE parts failures (after delivery from the manufacturer)	
Non compliance of Planetary protection requirements.	

MS-PA-REQ-3940

Verification:

Traces:

For co-ordinated procured items, in addition to the above provisions, the following applies:

Any major failure occurring during parts procurements and delivery must be notified to EXO-PCB within two (2) working days after it is detected. The NCR report shall be provided within five (5) working days with a clear description of the failure and a proposed disposition. EXO-PCB will release the lot for use only after review of the failure analysis report and closure of the corresponding NCR.

The user shall be in any case informed through the CPPA information system of any NCR (independently of the classification)

Users' formal approval of NCR disposition is requested whenever a major NCR could have impact in the form/fit/function (inclusive radiation and planetary protection) or potential impact in delivery time. In this case, NCR shall be distributed to users and they will be invited to the relevant NRB.

For components failing after/during assembly at higher level the user is responsible in performing the initial analysis necessary to identify the failed components and the failure effects/failure mode. The CPPA shall be involved once it has been shown that there is no misapplication/mishandling performed by the user.

If necessary an assessment of the surrounding parts shall be requested to the user, in order to assure that the surroundings components have not been overstressed.

7.5.3 Components in Off the shelf equipments

MS-PA-REQ-3950

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1080

All the requirements specified in this document are applicable also for components in OTS equipment intended for flight use. Therefore, the previous use or approval of a part (via PAD or otherwise) in any other project shall not be considered in any case as an approval for ExoMars. The project explicit approval as required in paragraph 7.4.4 above is applicable. Furthermore, the Radiation Hardness Assurance requirements of paragraph 7.4.2 is applicable for EEE parts in OTS.

7.5.4 Use of Stock Components

MS-PA-REQ-3960

Verification:

Traces:

Relife will be performed according to ECSS-Q-ST-60.

MS-PA-REQ-3970

Verification:

Traces:

The use of existing stock parts has to be approved via PAD by EXO-PCB.

CPPA is recommended to verify before starting new procurement, the parts stock procured for equivalent ESA programs, upon ESA approval, making a detailed comparison of quality and environmental requirements of EXOMARS programme with respect the program whose stock belongs to.

MS-PA-REQ-3980

Verification:

Traces:

When EEE parts from existing stocks are proposed to be used, the following conditions shall be met :

- The parts have been stored according to $22^{\circ}\text{C} \pm 5^{\circ}\text{C}$, humidity RH 55% max.
- The lot homogeneity and traceability can be demonstrated.
- The EEE parts documentation, including LAT/RVT/QCI/TCI documentation of the concerned lot is available and the content is acceptable in accordance with the programme requirements (including materials, planetary protection provisions and radiation data)

- The minimum overall requirements (e.g. screening) are in accordance with the present document
- No open NCR or no applicable alert exist for the relevant lot/date code.

7.5.5 EEE parts Documentation

MS-PA-REQ-3990

Verification:

Traces:

All documentation as required by the paragraph 5.7 of ECSS-Q-ST-60 shall be retained and made available for TAS/ESA.

MS-PA-REQ-4000

Verification:

Traces:

The delivery of documentation to TAS shall be conducted as specified in the DRD. Other documents related to EEE parts, like component manufacturer's data relevant to procurement, or lot-specific results, shall remain available for review by TAS/ESA for the duration specified in the contract.

MS-PA-REQ-4010

Verification:

Traces:

TAS/ESA reserves the right to request at any time a Data Package Review to verify that all activities and specifications, as agreed in the relevant PADs, have been effectively put in place in the procurement of components intended for Flight application prior to the actual integration of the components into Flight hardware.

MS-PA-REQ-4020

Verification:

Traces:

All initiated PADs shall be provided to TAS/ESA prior to actually commencing the evaluation and/or procurement of the relevant EEE component for ExoMars. TAS may decline responsibility if the procurement authority (CPPA or users) fails to complain with this requirement.

MS-PA-REQ-4030

Verification:

Traces:

Additionally, upon request, the procurement authority is responsible for the delivery to TAS/ESA of the following documentation relevant to EEE components used in the project, in electronic, unlocked, .pdf format with meta-data filled in:

- Part Approval Documents (signed)
- Component procurement specifications
- Component Evaluations
- Radiation Test data
- Construction Analysis and DPAs

MS-PA-REQ-4040

Verification:

Traces:

In case of confidential/proprietary documentation, users shall be available to organise meeting at their facilities in order to allow TAS/ESA review.

7.5.5.1 Parts manufacturer's documentation requirements

MS-PA-REQ-4050

Verification:

Traces:

As a minimum, the following documentation is required from the manufacturer for each delivery lot:

- Certificate of Conformance verifying that all requirements of the applicable purchase orders are met.
- Recorded values of measured parameters and calculated deltas related to serial numbers (if applicable).
- LAT test report/QCI report on the procured lot (whenever requested)
- QCI generic lot data (whenever requested)
- Any other data, defined in the applicable procurement standards

The originals of the documentation shall be stored at the facilities of the procurement authority and TAS/ESA shall have access to these originals on request.

7.5.6 Components Packaging, Handling and Storage

MS-PA-REQ-4060

Verification:

Traces:

Parts delivered to the users shall be packaged in accordance with the requirements of the procurement specification. For co-ordinated procured items CPPA is responsible for an adequate packaging of the parts. Users is responsible for maintaining appropriate packaging of EEE parts up to assembly.

MS-PA-REQ-4070

Verification:

Traces:

Components dedicated to EXOMARS program shall be stored in suitable containers placed in controlled area in which the access is limited to program involved personnel only.

MS-PA-REQ-4080

Verification:

Traces:

For co-ordinated procured items, CPPA has to inform via dispatch note about any special storage/handling condition requested (e.g. ESD sensitive devices, dry storage under nitrogen, etc.). Warning label indicating the required handling precautions shall be written in English and well visible in the external packages of the items.

MS-PA-REQ-4090

Verification:

Traces:

Parts will be handled and stored in accordance with the requirements of ECSS-Q-20B:

- Storage conditions shall be adequate to inhibit degradation of the surface finishes of the mounting areas of the components.
 - EEE parts will be stored in cleanliness controlled environment (22°C +/- 5°C) and Relative Humidity = 55% +/- 10%) with appropriate measures to segregate and protect components during receiving inspection, storage, and delivery to manufacturing.
 - Control measures to ensure that electrostatic discharge susceptible components are identified and handled only by properly trained personnel using anti static packaging and tools.
-

MS-PA-REQ-4100

Verification:

Traces:

Traceability of component application and relevant documentation shall be established and maintained updated under Q.A. responsibility.

MS-PA-REQ-4110

Verification:

Traces:

The procurement authority is also responsible to retain and store appropriately identified all LAT, type approval, QCI and destructive test samples.

MS-PA-REQ-4120

Verification:

Traces:

Whenever is needed the CPPA or users shall organize a Quarantine Store that must be separated to the EXOMARS flight store to store any non flight parts. As well for the quarantine stored items the traceability against NCR, LAT, type approval history shall be maintained.

7.5.7 Shipment

MS-PA-REQ-4130

Verification:

Traces:

Any shipment shall not be authorized if LAT, RVT, DPA, type approval testing, QCI, full data review and CoC are not completed. A user may request a premature shipment by taking over the fully responsibility. A shipment is constituted by the flight parts plus documentation.

MS-PA-REQ-4140

Verification:

Traces:

Whenever a shipment of components batch is ready, the CPPA shall communicate to the user copy to the Prime Contractor via Fax or within the Internet communication system scheme, as a minimum the following information:

- programme

- Part Number
- Lot Date Code
- Quantity
- Flight details/Courier details
- Special storage requirements
- Bioburden status (sterile/clean/uncontrolled manufactured)

7.5.7.1 Dispatch Documentation

MS-PA-REQ-4150

Verification:

Traces:

The CPPA shall ensure for each delivery of a flight lot that the following documentation is attached:

- CoC
- Receiving inspection report
- Any applicable NCR with the complete history
- Dispatch note
- Bioburden status (sterile/clean/uncontrolled manufactured)
- Any additional user requested documentation upon EXO-PCB approval.

MS-PA-REQ-4160

Verification:

Traces:

It is users' responsibility, for components received from the CPPA, to perform a visual inspection to verify absence of defects and to control the associated documentation.

MS-PA-REQ-4170

Verification:

Traces:

Any anomaly shall be managed by NCR emission.

MS-PA-REQ-4180

Verification:

Traces:

For self-procured items the user is responsible to perform in fully the incoming inspection/buy-off flow of activities.

7.5.8 Electrical and Qualification Model (EM/EQM)

MS-PA-REQ-4190

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1060

The EEE parts procurement for EM and EQM, is responsibility of the User.

For EM standard hardware the EEE parts shall be selected to be form, fit and function representative of the FM components. Additionally if thermal vacuum test are envisaged for the EM (for use in so called EQM, for example) the EEE parts used in it shall be made of the same materials, finish and processes as the flight equivalent part (different screening levels can be considered).

In addition to the above requirement, parts to be used in models intended for qualification purpose (EQM) will preferably have the same manufacturer as the parts to be used in PFM and FM.

The components selected for EQM shall be hermetic sealed and compatible to dry heat sterilization process, if EQM will be used to qualify the planetary protection compatibility (plastic packages shall be avoided) and shall meet the extended temperature range (as a minimum from - 55° C to + 125° C or compatible to dry heat sterilization temperature if requested).

The FPGA used in EM/EQM shall be necessarily from the same manufacturer with the guarantee to be fit, form and function representative, possibly with the same chip as the parts intended for flight. The P/N of the FPGA to be used in EM/EQM shall be listed in the user DCL relevant to FM, properly remarked as "EM or EQM parts".

Referring to Paragraph 3.10 of the present documents, EEE part changes must be intended as follow:

- Change of part type or
- Change of package or
- Change of manufacturer
- In case where the application is particular sensitive to an electrical characteristic and the relevant range reported in the specification/data sheet is reduced or different
- Feature/capability used in the EQM parts and not available in the FM part

In the EIDP of EQM, the EQM component list shall be included. This list shall include as a minimum the following information for each line item:

- Part number
- Description
- Package
- Manufacturer
- Procurement specification

7.5.9 Ground Support Equipment

MS-PA-REQ-4200

Verification:

Traces:

The procurement level of components to be used in EGSE shall be adequate to avoid any impact on mission success.

MS-PA-REQ-4210

Verification:

Traces:

In particular, the following aspects shall be carefully considered when procuring EGSE parts:

- to avoid EXOMARS troubles caused by EGSE failure
- to avoid EXOMARS mission delay caused by EGSE failure
- to ensure acceptable life time and availability of EGSE equipment.

MS-PA-REQ-4220

Verification:

Traces:

Non flight parts (i.e. connector savers) interfacing directly with flight hardware during manufacturing, assembly and test shall be selected procured and tested at flight standard level.

8. MATERIALS, PROCESSES AND MECHANICAL PARTS (MPM)

8.1 General

MS-PA-REQ-4230

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1640

Each supplier shall define in his 'Product Assurance Plan' the Materials, Parts and Processes organisation and tasks. It shall identify a Materials and Processes Manager for the ExoMars project. The requirements of ECSS-Q-70B shall be followed with the following modifications:

8.2 Declared Material/Parts and Process Lists

MS-PA-REQ-4240

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1650

The Subcontractor and Supplier Materials and Processes Manager shall review all lists and produce a fully consolidated:

- Declared Material List (DML)
- Declared Mechanical Part List (DMPL)
- Declared Process List (DPL)

In addition to the RFA process as defined in ECSS-Q-70B, RFA shall also be required for parts or materials, which are proposed for use after the declared PMP list is approved by TAS-I/ESA. Such parts or materials shall not be incorporated in the Technical Baseline prior to TAS-I/ESA approval via the RFA process.

MS-PA-REQ-4250

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1660

A breakdown of such lists is given in ECSS-Q-70B. In addition, the lists shall include proper definition of bioburden reduction environment and indication for compatibility.

8.2.1 PMP Item number

MS-PA-REQ-4260

Verification:

Traces:

Sequential item number, once assigned to a material/part/process inside the List, shall not be changed, deleted or re-assigned.

MS-PA-REQ-4270

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1670

The Prime-contractor shall determine and decide upon the acceptability of each line item on the DML, DMPL and DPL prior to delivering each list to ESA for final approval.

MS-PA-REQ-4280

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1680

The DML/DMPL/DPL shall be provided in an electronic form that is exchangeable, searchable and sortable and suitable for storage and retrieval.

Outputs:

- PA-27: 'Declared Material List (DML)
- PA-28: 'Declared Mechanical Part List (DMPL)
- PA-29: 'Declared Process List (DPL)
- PA-45: 'Request For Approval'

MS-PA-REQ-4290

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1690

A Materials & Process Control Board shall be established starting after successful PDR.

Output PA-30 Deleted:

8.3 Technical Requirements for the Selection of Materials

MS-PA-REQ-4300

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1700

Specification ECSS-Q-70-71A rev1 contains data on materials that have been evaluated and tested for use in space hardware and it can be used as a source for material selection. The data herein shall be used preferentially for the selection of materials with a previous history of space use in similar applications.

According to ECSS regulations, these "Informative annexes" give additional information (e.g. guidelines, suggestions) but shall not contain any normative provisions. Presence of a material in this informative annex does imply that the material has been used successfully in past space missions. This is however in itself not a sufficient justification for its use in another space application.

Selection shall be based on the availability of relevant and up-to-date data on the material/process as used, demonstrating the compatibility of that material/process with the given application.

Equivalent standards from MIL system or NASA may also be accepted pending compliance review.

Output: This shall be fulfilled through the deliverables PA-27, PA-28, and PA-29.

8.3.1 Deleted

8.4 Verification of curing conditions

MS-PA-REQ-4310

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1720

For materials and processes that require witness sampling, in-process witness samples shall be prepared under representative conditions from the same materials batch as used on hardware. The witness samples shall be stored in proper conditions until launch (QM) and end of mission (FM).

Output: PA-31: Deleted

8.5 Forbidden Materials

The use of pure mercury, tin, cadmium, zinc, and PVC is prohibited. For safety reasons the use of Beryllium and Beryllium oxide shall be restricted and, in case of use, the item shall be suitably labelled.

MS-PA-REQ-4330

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1740

Forbidden materials are also applicable to GSE to be installed in the vacuum chambers and clean rooms near flight hardware.

Output: The requirements shall be fulfilled through the deliverables PA-27, PA-28.

Deleted

8.5.1 Use of radioactive and fluorocarbon materials

MS-PA-REQ-4340

Verification:

Traces:

Carcinogens materials, CFC shall not be used.

MS-PA-REQ-4350

Verification:

Traces:

Radioactive materials shall be used only when strictly necessary and using the dedicated control procedures.

MS-PA-REQ-4360

Verification:

Traces:

Radioactive materials shall be used only when strictly necessary and using the dedicated control procedures.

MS-PA-REQ-4370

Verification:

Traces:

PTFE-polytetrafluoroethylene (PTFE) and other non treated fluorocarbons materials are sensitive to cold flow. The use of wire made of these materials is prohibited. Duly justified deviation could be accepted for ex. if it is demonstrated that workmanship prevents from cold flow (controlled bend radii, no contact with sharp objects, wire fixation rules etc.). The use of irradiated ETFE-ethylenetetrafluoroethylene (TEFZEL) wires with improved characteristics against cold flow is accepted.

MS-PA-REQ-4380

Verification:

Traces:

Electrical wires or cables insulated or coated with fluorocarbon shall be etched prior to potting to ensure mechanical bond strength and environmental seal. The open end of the wire shall not be exposed to the etchant.

MS-PA-REQ-4390

Verification:

Traces:

Electrical wires or cables insulated or coated with fluorocarbon shall be etched prior to potting to ensure mechanical bond strength and environmental seal. The open end of the wire shall not be exposed to the etchant.

8.6 Bioburden control

MS-PA-REQ-4400

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1760

Hardware compatibility with bioburden control procedures as defined in the Planetary protection requirements EXM-MS-RS-ESA-00005 [NR 26] shall be demonstrated.

Output: The requirement shall be fulfilled through the deliverables PA-27 and PA-28

8.7 Bioburden Reduction

Deleted

Deleted.

Deleted

MS-PA-REQ-4410

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1800

The bioburden reduction process on assemblies and the impact of bioburden reduction on long duration effects (e.g. during storage and flight) shall be demonstrated on critical hardware (e.g. parachute, airbags).

Output PA-32: 'Data for compatibility with processes for bioburden reduction'

8.8 Vacuum

MS-PA-REQ-4420

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1810

The acceptance criteria for materials used for space applications (vacuum compatibility is also applicable to GSE to be installed in the chamber) shall be compliant with ECSS-Q-ST-70-02 with the addition of the following:

MS-PA-REQ-4430

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1820

The primary data source for assessment of vacuum compatibility shall be the ESA database available online: http://esmat.esa.int/Services/outgassing_data/outgassing_data.html

MS-PA-REQ-4440

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1830

When relevant outgassing data are not available (e.g obsolete if test conducted more than 10 years ago, or unacceptable because missing information such as report reference or insufficient materials/processes description), out-gassing tests shall be carried out as per ECSS-Q-ST-70-02 .

MS-PA-REQ-4450

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1840

The outgassing and condensation acceptance criteria for a material depends upon the application and location of the material and may be more severe than the general outgassing requirements for material selection, which are defined as RML < 1,0% and CVCM < 0,10%. The validity of this screening test as a means for determining the suitability of a material for a specific application shall depend on the environmental conditions during the lifetime of the material as well as the vicinity of critical or sensitive

surfaces. Especially, in cases where the expected maximum temperature of a material during the lifetime is exceeding for longer periods 50°C the use of such material shall be evaluated further through an appropriate test program, mutually agreed between customer and supplier. Such program shall ensure that the characteristics of the material at the EOL are still within the specified requirements.

Output: The requirement shall be fulfilled through the deliverable PA-27.

Deleted

MS-PA-REQ-4460

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1860

In view of contamination criticality (for instance in the vicinity of sensitive optical surfaces or surfaces that come in contact with Mars samples) more stringent requirements or more detailed material information, such as outgassing data according to ESA VBQC test are required. The results shall be reflected in DRD PA-09

8.9 Thermal Cycling

MS-PA-REQ-4470

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1870

Materials (incl. non-flight hardware) subject to thermal cycling shall be assessed to ensure their capability to withstand the induced thermal stresses following ECSS-Q-ST-70-04 .

MS-PA-REQ-4480

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1880

Materials used at cryogenic temperatures (80 K or lower) shall be qualified for the worst-case conditions.

8.10 Environmental Interaction

MS-PA-REQ-4490

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1890

When considering the materials environment it should be noted that atomic oxygen might be present during the earth escape orbit and the Mars insertion/operation orbit. The amount of atomic oxygen shall be predicted and its effect on materials shall be estimated. Particularly sensitive materials shall be avoided. The survivability of materials in the Martian environment (atmosphere, sand, etc.) for orbit /landing and operation shall be demonstrated if applicable

MS-PA-REQ-4500

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1900

Materials exposed to the sun shall comply with PSS-01-706 for UV radiation and, if applicable, for particle radiation. Materials exposed to space but not to the sun shall comply with PSS-01-706 and the ExoMars radiation environment.

8.11 Micrometeoroid/Debris Environment

MS-PA-REQ-4510

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1910

The influence of a Micrometeoroid/Debris Environment on the materials shall be examined on a case-by-case basis.

8.12 Electrochemical Compatibility

MS-PA-REQ-4520

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1920

When bimetallic contacts are used, the choice of the pair of metallic materials used shall take into account ECSS-Q-70-71A rev1 (paragraph 5.2.14) or MSFC-SPEC-250 (Protective finishes for space vehicle structure and associated flight equipment general specification for) data. Galvanic compatibilities shall be selected in accordance with Group 0, couples that can be used without restriction, and Group 1, couples that can be used in a non-controlled environment, of Table 1 of ECSS-Q-70-71: *Compatible couples for bimetallic contacts*. Materials not listed in Table 1 of ECSS-Q-70-71 shall

be evaluated in a mission-simulated configuration.

This requirement applies also to metal-to-conductive fibre-reinforced contacts.

Deleted.

MS-PA-REQ-4530

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1940

Materials for hardware where bioburden assessment procedures will be applied (e.g. wet contact by swabbing, wiping) shall be considered as being in a non-controlled (humidity) environment.

Deleted

8.13 Corrosion

MS-PA-REQ-4540

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1960

Aluminium surfaces shall be treated for corrosion protection with a chemical conversion Coating or with the most appropriate method. In case that black anodizing protection will be selected for AA series 2xxx and 7xxx, ESA ALERT EA-2005-MEP-02-B shall be also followed. Mechanical parts made of stainless steel shall be 'passivated'. Mechanical parts made of Titanium alloys shall be anodised.

Deleted

8.14 Stress Corrosion

MS-PA-REQ-4550

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-1980

Metallic materials used in structural applications shall have a high resistance to Stress Corrosion Cracking (SCC) and shall be chosen from Table 5-1 of ECSS-Q-ST-70-36 .
Metallic materials and welds that are not listed in ECSS-Q-ST-70-36 or whose SCC resistance is unknown shall be tested and categorised according to the requirements of ECSS-Q-ST-70-37.

Deleted

8.15 Fluid Compatibility

MS-PA-REQ-4560

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2000

Materials that will be in permanent contact during planned operations with an identified fluid shall be compatible with that fluid. If compatibility data are not available, then testing shall be performed according NASA-STD-6001 , test number 15. That compatibility shall be identified in the DML and DMPL.

Output: The requirement shall be fulfilled through the deliverables PA-27 and PA-28.

Deleted

8.16 Allowable Stress

MS-PA-REQ-4570

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2020

Allowable stresses for materials shall be derived from MIL HDBK 5 (Metallic materials and elements for aerospace vehicle structures). Other sources shall be subject to ESA approval. Composite structure allowable stresses shall allow for degradation due to moisture, temperature and process variables. The material justification shall prove hardware structural integrity during storage and on-orbit life time.

MS-PA-REQ-4580

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2030

Fracture sensitive materials shall be subjected to fracture control as in ECSS-E-30-01 (Fracture control), ECSS-Q-ST-70-36 (Material selection for controlling stress corrosion cracking) and ECSS-Q-ST-70-37 (Determination of susceptibility of metals to stress corrosion cracking). Materials for which no fracture mechanics data is available from MIL HDBK-5 [NR 70] shall be tested in acc. with ECSS-Q-ST-70-45.

8.17 Limited Life Time

MS-PA-REQ-4590

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2040

Materials with limited-life characteristics shall be subject to lot/ batch acceptance tests, according to ECSS-Q-ST-70-22 (Control of Limited Shelf-life Materials).

MS-PA-REQ-4600

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2050

Items and materials that have a limited life after assembly/integration shall be identified and processed in the Critical Item List (CIL, PA-3)
Output PA-35: Deleted

8.18 Processes

MS-PA-REQ-4610

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2060

This chapter is a supplement to clause 7.7 of ECSS-Q-70B.

MS-PA-REQ-4620

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2070

The Contractor shall maximize the use of existing ESA specifications. The following specifications listed in the normative documents list shall be applicable:

- ECSS-Q-ST-70-08C for soldering
- ECSS-QST-70-18C for RF coaxial cable assembly
- ECSS-Q-70-26A for crimping
- ECSS-Q-ST-70-28C for repair and modification of PCB's
- ECSS-Q-ST-70-38C for high reliability soldering for surface mount and mixed technology.

The requirements shall be fulfilled through the deliverable PA-36.

.Output PA-36: High Reliability soldering for surface mount and mixed technology

MS-PA-REQ-4620

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2070

The Contractor shall maximize the use of existing ESA specifications. The following specifications listed in the normative documents list shall be applicable:

- ECSS-Q-ST-70-08C for soldering
- ECSS-QST-70-18C for RF coaxial cable assembly
- ECSS-Q-ST-70-26C for crimping
- ECSS-Q-ST-70-28C for repair and modification of PCB's
- ECSS-Q-ST-70-38C for high reliability soldering for surface mount and mixed technology.

The requirements shall be fulfilled through the deliverable PA-36.

.Output PA-36:Deleted

MS-PA-REQ-4630

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2080

Equivalent standards from MIL system or NASA may also be accepted pending compliance review.

Deleted

8.18.1 Process procedures

MS-PA-REQ-4640

Verification:

Traces:

Process procedures shall include sufficient inspections and tests during and at the end of the processing steps to assure that the characteristics of the product are within the required limits,

MS-PA-REQ-4650

Verification:

Traces:

When not included in specific process procedures, appropriates MIPs and KIPs shall be introduced as per ECSS-Q-20B section 8.9 for process control.

MS-PA-REQ-4660

Verification:

Traces:

Process procedures shall be made available or accessible to TAS/ESA upon request (e.g. during audits, during the Final Design Review before start of QM/FM-manufacturing, or for failure investigations) for review that all processing steps are adequately specified and that adequate controls are included; proprietary rights will be respected

8.18.2 Processes for EEE mounting and assembly.

MS-PA-REQ-4670

Verification:

Traces:

The contractor shall demonstrate the adequacy and the qualification status of his mounting and assembly rules for each package technology and material, as reported in paragraph 3.4.6 ("EEE components requirements on materials and processes") of this PA requirements.

8.19 Printed Circuit Boards

MS-PA-REQ-4680

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2120

Printed circuit boards shall be procured from an ESA qualified source according to ECSS-Q-ST-70-11C . The qualification of printed circuit boards shall comply with ECSS-Q-ST-70-10C .

8.20 Fasteners

MS-PA-REQ-4690

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2130

Fasteners shall be manufactured and procured in acc. with the requirements in ECSS-Q-ST-70-46C .

9. SW PRODUCT ASSURANCE

MS-PA-REQ-4700

Verification:

Traces:

All SW PA Requirements are placed in dedicated and applicable document "SW PA Requirements for Subco's" **EXM-MS-RQM-AI-0010**.

10. QUALIFICATION STATUS REPORTING

10.1 Off-the-shelf (OTS) Equipment (DRD PA-42)

MS-PA-REQ-4710

Verification:

Traces:

Subcontractor and Supplier will prepare an OTS list .This document to be submitted to TAS/ASI for review and Approval as per DRD PA-42.

MS-PA-REQ-4720

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2220

An “ Off the shelf “ item is an item originally developed for a different project (though possibly with a common or generic application) which has been selected for reuse in the current project.

MS-PA-REQ-4730

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2230

The Contractor who decides to use an OTS item shall demonstrate its full suitability with the ExoMars requirements, both on technical and PA aspects.

MS-PA-REQ-4740

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2240

OTS equipment shall be able to withstand the environmental conditions applicable to the ExoMars Mission during all mission phases.

MS-PA-REQ-4750

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2250

Depending on the intended use, the following classes of OTS equipment can be identified:

- Equipment developed, built and qualified for other space projects under PA requirements equivalent to the ones of this document (equipment "S"). "S" equipment may be used for flight applications.
- Equipment developed and built for commercial, aviation or military applications (equipment "CAM"). "CAM" equipment may be used for non-flight applications.

MS-PA-REQ-4760

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2260

The use of OTS equipment shall not lead to the violation of any applicable safety requirement.

MS-PA-REQ-4770

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2270

System-level reliability and safety analyses (e.g., the FMEA) shall consider also OTS equipment failures. Candidate OTS equipment shall be reviewed by an Equipment Suitability Board chaired by a customer representative and including the PA function. It shall ensure that the proposed OTS meet the environmental and PA requirements.

MS-PA-REQ-4780

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2280

Following the review, the board shall issue an assessment and justification report. The Report shall contain as a minimum:

- ExoMars Technical specification identifying the ExoMars requirements
- Justification file clearly identifying any non compliance between the ExoMars requirements and the actual characteristics/ performances of the item,
- Delta activities program describing all necessary tasks to be performed to verify the fulfilment of the ExoMars requirements, if any,
- OTS Item Suitability report presenting the results of the Delta activities and demonstrating the full suitability of the OTS item.

MS-PA-REQ-4790

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2290

For each OTS Item, a dedicated OTS Item suitability review shall be held. This review shall take place not later than the PDR of the Upper Subassembly level.

MS-PA-REQ-4800

Verification:

Traces: EXM-MS-RS-ESA-00002#PA-SY-2300

The Delta Activities program shall be completed not later than the CDR of the Upper Subassembly level.

10.2 Qualification Status List (QSL)

MS-PA-REQ-4810

Verification:

Traces:

A Qualification Status List (QSL) will be issued at equipment, subsystem and system levels (DRD PA-TAS-1).

MS-PA-REQ-4820

Verification:

Traces:

This document summarises for each configured equipment, by reference to design definition, or build standard, the test requirements and results, and the manner by which a qualified status, compliant with the Customer's project requirements, is achieved.

MS-PA-REQ-4830

Verification:

Traces:

The list will include the following information:

- Equipment designation : identification of hardware by name, Configuration Item number and model
 - Next higher assembly level
 - Manufacturer's name : Supplier
 - Proposed category A, B, C, or D as defined hereabove
 - Current qualification status/screening and applicability of qualification test versus requirements: with applicable qualification requirements (with reference documents) and relevant RFDs
 - basis for qualification (qualification test results, heritage, and qualification on other projects)
- programme on which the qualification test was conducted issued from specific Equipment Qualification Status Review as far as a heritage is identified (Applicable documents which show the qualification

achievement and relevant RFWs issued during the test campaign)

- Project on which the test was conducted
- test Report number.
- Identification of developments models (EM, EQM, QM, PFM) to be manufactured and tested for the project if necessary.
- the qualification status

MS-PA-REQ-4840

Verification:

Traces:

The qualification model will be fully representative of the flight model and any differences have been analysed to evaluate their effects on the qualification status.

11. PA REQUIREMENT FOR GSE

MS-PA-REQ-4850

Verification:

Traces:

This chapter gives clarification about the requirements dedicated to GSE.

11.1 PA Management

MS-PA-REQ-4860

Verification:

Traces:

The Subcontractor shall implement a PA programme.

The Product Assurance program to be carried out by the subcontractors and suppliers shall be in accordance with ECSS-Q-00A and shall include the disciplines of Quality Assurance; Software Product Assurance; Safety Assurance; Dependability; Component Quality, Selection and Procurement; Materials Parts and Process Selection and Control; Configuration management Control and Acceptance Activities (ref. para 3 and 4 of this document)

11.1.1 Reviews

MS-PA-REQ-4870

Verification:

Traces:

As per para 3 and 4 of this document.

11.1.2 Design and Manufacture

MS-PA-REQ-4880

Verification:

Traces:

Appropriate quality requirements and procedures shall be established and achieved through the design, procurement, fabrication, assembly, inspection, testing, packing and storing phases of the contract .

MS-PA-REQ-4890

Verification:

Traces:

Quality assurance activities shall be applied to the following subjects:

- Safety provision including assurance that the flight hardware will not be exposed to potentially hazardous conditions during handling or testing
- Safety verification with appropriate certification (e.g. proof loading test for lifting devices)
- Reliability of the interface to the flight hardware shall be verified by FMECA
- Configuration Control
- Non-Conformance control during acceptance testing
- Handling and Storage control
- Identification/markings
- Calibration
- Quality Assurance of materials and parts where contact is made to flight standard hardware
- Witness of acceptance testing
- Quality assurance of software

11.1.3 Documentation

MS-PA-REQ-4900

Verification:

Traces:

The GSE shall be delivered with the following documentation:

- Certificate of Compliance
- Compliance Matrix
- VCD
- List of deliverable items
- List of spare items
- Configuration Status List (As design/as built)
- Drawing files with all necessary drawings (ICD, Pin Allocation Lists, Installation Documents etc)
- List of NCR (Major and Minor)
- NCR/NRB Reports (Major only)
- RFD/RFW List and copies
- Historical records, Calibration Data Status List, Calibration Dates
- Inspection Results
- Acceptance Test Reports
- User Manuals
- Maintenance manuals
- DRB MOM's, TRR's/PTR's MOM's, Action Item Lists,
- Open Work, Deferred Work, Open Test
- Temporary Installation
- Transportation, Handling and Installation Procedures

- Shipping Documents
- Supporting Documents such as:
- Inspection requirements (before use)
- Proof Load certificates
- Hazard Analysis with the closure of Residual Hazard Sheets
- S/W Configuration Status List
- FMECA
- CIL
- CE Certification (SEE section 11.1.11)

MS-PA-REQ-4910

Verification:

Traces:

The EIDP shall be initiated prior to and maintained during all stages of assembly, inspection and test for each of the equipment specified. Complete copies of the EIDP's shall be submitted to higher level contractors. Quantity 2 to Thales Alenia Space and Quantity 1 to ESA at least 15 working days prior to the Delivery Review (final updates may be given at the review).

MS-PA-REQ-4920

Verification:

Traces:

The EIDP shall be delivered in hard copies plus CD ROM support.

MS-PA-REQ-4930

Verification:

Traces:

Updates of EIDP's have to be provided if GSE are returned for any modification/corrective actions

11.1.4 GSE Dependability and Safety

MS-PA-REQ-4940

Verification:

Traces:

The requirements defined in Para. 5 Dependability and Para. 6 are applicable to:

- Portions of the GSE which interface directly with flight hardware

- GSE design, manufacturing, operation having impact on safety (e.g. MGSE, testing/documentation for lifting slings)

with the clarifications and modifications presented in this section.

MS-PA-REQ-4950

Verification:

Traces:

[] For GSE purpose the FMECA shall be limited to the interfaces with flight hardware. The analysis shall not be limited to electrical interfaces. As appropriate, mechanical, thermal, optical interfaces, etc. shall be included.

MS-PA-REQ-4960

Verification:

Traces:

[] The FMECA shall consider functional failures inside the GSE that may propagate via the interfaces with the flight hardware or other hardware.

MS-PA-REQ-4970

Verification:

Traces:

The FMECA shall be supported by a functional block diagram showing all units analysed and a short description of each block. The breakdown of each block and its identification shall be such that they can be traced in the FMECA sheets.

MS-PA-REQ-4980

Verification:

Traces:

[] For the GSE interfaces with the S/C the FMECA shall be performed at parts level.

MS-PA-REQ-4990

Verification:

Traces:

[] In the case that a failure may propagate through an interface the contractor shall define, agree and trace dedicated actions to remove the non compliance. If removal is considered not feasible, justification for retention of each identified critical failure shall be submitted to TAS-I for approval.

MS-PA-REQ-5000

Verification:

Traces:

[] The following failure consequence Severity Categories shall be used in the FMECA for GSE:
Category 1: Failure propagation. Possible damage to, or overstress of flight hardware or other hardware.
Category 2: Failure is contained. Degradation of operational capability of the GSE under consideration

MS-PA-REQ-5010

Verification:

Traces:

[] Improper commands or command sequences or software errors shall not cause undesired effects as specified in Para. 5.3.2 Failure Tolerance

MS-PA-REQ-5020

Verification:

Traces:

[] The GSE shall by design avoid that its operation, alone or connected to the S/C, could lead to hazardous conditions which may have catastrophic or critical consequences.

MS-PA-REQ-5030

Verification:

Traces:

[] Protection systems (such as over-voltage protection circuits, mechanical end stops, relief valves, etc.) shall be implemented in the GSE design for those failures which may propagate to any interfacing flight hardware or other hardware or may have safety impacts.

MS-PA-REQ-5040

Verification:

Traces:

[] The EGSE shall provide built-in self test capability for failure detection and isolation.

MS-PA-REQ-5050

Verification:

Traces:

[] EGSE functions shall be continuously self-monitored. It shall also be possible to monitor them through a local operator interface and remotely by the central checkout system.

MS-PA-REQ-5060

Verification:

Traces:

[] The EGSE shall be able to automatically and safely switch off the failed function.

MS-PA-REQ-5070

Verification:

Traces:

[] All resources required for detection, isolation and switching off the failed function shall be implemented and shall not be affected by the initial failure.

MS-PA-REQ-5080

Verification:

Traces:

[] The Contractor shall identify the equipment parameters and functions that are critical for its performances and safety.

11.1.5 General Requirements

MS-PA-REQ-5090

Verification:

Traces:

As per para 11.1.4

11.1.6 FMECA

MS-PA-REQ-5100

Verification:

Traces:

As per para 11.1.4

11.1.6.1 Criticality Categories

MS-PA-REQ-5110

Verification:

Traces:

As per para 11.1.4

11.1.7 Critical Item

MS-PA-REQ-5120

Verification:

Traces:

FMECA.A Critical Item List shall be provided, the requirements defined in Para. 4.4 "Critical Items Control" and Para. 5.5 "Inputs to Critical items list" are applicable.

11.1.8 Safety

MS-PA-REQ-5130

Verification:

Traces:

As per para 11.1.4

11.1.9 Materials

MS-PA-REQ-5140

Verification:

Traces:

Materials which interfaces with flight hardware shall be selected in order to not degrade or contaminate it.

MS-PA-REQ-5150

Verification:

Traces:

The selection criteria shall be met for out-gassing, thermal cycling, corrosion, stress corrosion, fluid compatibility.

MS-PA-REQ-5160

Verification:

Traces:

In addition the materials shall not be flaking or dusting so that a high degree of cleanliness of the flight hardware can be achieved and maintained.

11.1.10 Cleanliness and PP

MS-PA-REQ-5170

Verification:

Traces:

The GSE shall be cleanable in order to reach the cleanliness level of the flight hardware with which it interfaces. For optical non cleanable devices cleanliness monitoring shall be applied.
For PP subject apply dedicated program specification EXM-MS-SSR-AI-0007 [NR 0120]

11.1.11 GSE Certifications (UE certification / USA certification)**11.1.11.1 UE GSE Suppliers**

MS-PA-REQ-5180

Verification:

Traces:

All GSE to be provided with CE Marking and certified on the bases of the following standard:

- Directive UE machine (2006-42-EC)
- Directive LOW Voltage 2006/95/EC (12.12.2006)
- Directive EMC 2004/108/EC (15.12.2004)

11.1.11.2 USA GSE Suppliers

MS-PA-REQ-5190

Verification:

Traces:

- USA GSE will provided by a certification comparable to UE standard. (CE marking).
- USA GSE have to satisfy Safety requirements placed in Para 4.3.2 of document KHB 1700.7

12. DRL FOR PRODUCT ASSURANCE

12.1 HW/SW DRL PA DOCUMENTS (25)

MS-PA-REQ-5200

Verification:

Traces:

The following table identified complete set of all PA documentation applicable at Program level.
Specifically required PA documents related to each item are listed in the relevant SOW DRL.

Item	Numb	DRD Ref.	Title	Submittal	Proposal	PDR	MRR/CDR	QR	DRB	Class	Remark
			For HW/SW contractors the following listed items are applicable.								
PA-	1	PA-01	Product Assurance (PA) and safety plan		x	x	x			AR	Including the Compliance Matrix versus PA Requirements for Subcontractors
PA-	2	PA-02	Audit plan			x	x			A	Living document
			Audit report							R	For each audit performed
PA-	3	PA-03	Critical Items Control Plan		x	x	x	x		A	Can be part of PA Plan
			Critical Items List			x	x	x	x	A	including Limited Life Items list (was PA-35)
PA-	4	PA-04	Non Conformance Reports (NCR)	As generated						A	Major for approval; minor for review
PA-	5	PA-05	Request for Waiver (RFW)		x	x	x	x	x	A R	Approval of template at KO, later updates for review
PA-	6	PA-06	Alert assessment report		x	x	x	x	x	AR	Approval of template at KO, later review, final approval at FAR. At progress meeting updated alert status list.
PA-	7	PA-07	Cleanliness Requirement Specification (CRS)								N/A to subco
PA-	8	PA-08	Cleanliness and Contamination Control Plan (C&CCP)			x	x			A	
PA-	9	PA-09	End of Life Cleanliness Analysis			x	x	x		AR	Approval at CDR
PA-	10	PA-10	End Item Data Packages (EIDP) for all h/w and s/w						x	AR	Acceptance at FAR
PA-	11	PA-11	Failure Mode Effect and Criticality Analysis (FMECA) incl. HSIA and CM CC			x	x	x		A	Use TAS-I Template
PA-	12	PA-12	Reliability Assessment Report			x	x	x		R	
PA-	13	PA-13	Worst Case Analysis				x	x		R	
PA-	14	PA-	Parts Derating Analysis Report				x	x		R	Removable for

Item	Numb	DRD Ref.	Title	Submittal	Proposal	PDR	MRR/CDR	QR	DRB	Class	Remark
		14									PDR if too early for unit design not consolidated
PA-	15	PA-15	Maintainability Report				x	x	x	AR	Acceptance at FAR only
PA-	16	PA-16	(input to) FDIR Capabilities verification report								DELETED
PA-	17	PA-17	Safety Data Package	safety reviews			x	x	x	R	To be updated also in support of System Reviews.
PA-	18	PA-18	Safety Certificates incl. Accident Incident Investigation Reports								DELETED
PA-	19	PA-19	System(/Subsystem/Equipment) and Operations Hazard Analysis			x	x	x		R	To be updated also in support of System Reviews. Acceptance at FAR only
PA-	20	PA-20	EEE Component Control Plan		x	x				AR	as part of PA-1
PA-	21	PA-21	Parts Control Board Implementation Plan								DELETED
PA-	22	PA-22	Declared Component List		x	x	x	x	x	A	Draft at proposal including item to be developed or qualified. Final approval of "as design" DCL at subsystem / Unit CDR. Final approval of "as BUILT" at DRB . To be updated also in support of System Reviews. At equipment DRB the DCL shall reflect the as-built configuration (including D/C of components) For proposal special attention shall be paid to LLIs
PA-	23	PA-23	Radiation Hardness Assurance Plan							A	as part of PA-01
PA-	24	PA-24	Radiation Analysis			x	x	x		AR	Final approval at Subsystem/Unit CDR and QR.
PA-	25	PA-25	Parts Application Analysis (Parts Stress Analysis)								DELETED , covered by PA-14
PA-	26	PA-26	Part Approval Document (PAD)	As generated						A	Final approval at equipment CDR
PA-	27	PA-27	Element/Subsystem/Unit Level Declared Materials List (DML)			x	x	x		A	Form excel provided by TAS-I
PA-	28	PA-28	Element/Subsystem/Unit Level Declared Mechanical Part List (DMPL)			x	x	x		A	It can be a separate section of DML
PA-	29	PA-29	Element/Subsystem/Unit Declared Processes List (DPL)			x	x	x		A	Form excel provided by TAS-I
PA-	30	PA-30	Material and Processes Control Board								DELETED
PA-	31	PA-	Process witness materials								DELETED

Item	Numb	DRD Ref.	Title	Submittal	Proposal	PDR	MRR/CDR	QR	DRB	Class	Remark
		31	inventory list								
PA-	32	PA-32	Data for compatibility with processes for bioburden reduction			x	x	x	x	AR	Acceptance at QR only. To be updated also in support of System Reviews.
PA-	33	PA-33	Hardware compatibility with bioburden assessment procedures								DELETED covered by PA-27/28/29.
PA-	34	PA-34	Materials justification for contamination critical hardware								COVERED BY PA-09
PA-	35	PA-35	Limited life items status list								DELETED Covered by PA-3
PA-	36	PA-36	High reliability soldering for surface mount and mixed technology								DELETED
PA-	37	PA-37	Software PA Plan		x	x	x			AR	for acceptance at KO and s/s PDR, others for review
PA-	38	PA-38	Software Criticality Analysis Report			x	x	x		AR	for acceptance at System PDR and S/S PDR, others for review
PA-	39	PA-39	SW PA Requirements for Subco's								Subco has to use TAS-I doc EXM-MS-RQM-AI-0010
PA-	40	PA-40	Software Product Assurance Report			x	x	x	x	R	
PA-	41	PA-41	Software Maintenance File					x	x		for acceptance at QR and for review at FAR
PA-	42	PA-42	OTS list and related justification reports			x					Included in PA-TAS1
PA-	43	PA-43	Hazard Analysis and Safety critical functions at System Level								DELETED Applicable PA-19
PA-	44	PA-44	Inputs to Safety Data Package for Launch Vehicle	safety reviews							DELETED part of PA-17 and PA-19
PA-	45	PA-45	Request For Approval (RFA) for materials & processes	As generated						A	
PA-	TAS1		Qualification Status List		x	x	x	x	x	R	Including proposed off-the-shelf (OTS) items; format template will be provided
PA-	TAS2		Qualification Plan		x	x	x	x			Included in Eng-25
PA-	TAS3		MIP/KIP Manufacturing & Inspection Flowcharts/LIST			x	x			A	
PA-	TAS4		MIP/KIP Reports	As generated						R	Reports to be provided at MIP/KIP
PA-	TAS5		Non Conformance Report Review Board (NRB)	As generated						R	
PA-	TAS6		Status lists (ALERT-RFA-PAD-NCR (M&m)-SPR-RFD-RFW-MIP			x	x	x	x	A	To be delivered also as part of PA Progress Report
PA-	TAS7		Product Assurance Progress Report	as Project PR						R	Part of Project Progress Report; content see PARS

Item	Numb	DRD Ref.	Title	Submittal	Proposal	PDR	MRR/CDR	QR	DRB	Class	Remark
PA-	TAS8		Request For Approval (RFA) for materials & processes	As generated						A	DELETED replaced by PA-45
PA-	TAS9		Procurement Status Report	monthly						R	for selfprocured parts; should also be part of PA-TAS7
PA-	TAS10		User Parts List	As necessary						R	The user part list can be in excel format but under configuration control shall be presented to EXM-PCB for initiating/updating coordinated procurement
PA-	TAS11		Test Readiness Review Report	As generated						I	As called by ECSS-Q-20-07A annex B and ECSS-Q-020B para 9.5
PA-	TAS12		Test Review Board Report	As generated						I	As called by ECSS-Q-020B para 9.3
PA-	TAS13		S/W PA deliverable documentation								Deleted
PA-	TAS14		Configuration Management Plan							A	including software Covered by MT-3
PA-	TAS15		Part Procurements documentation	As generated						R	
PA-	TAS16		Components Control Plan							A	as part of PA-1
PA-	TAS17		Failure analysis report	As generated						R	
PA-	TAS18		Hardware/ Software Interaction Analysis			x	x	x		R	as part of PA-11
PA-	TAS19		Common Mode / Common Cause analyses			x	x	x		R	as part of PA-11
PA-	TAS20		Functional Analysis Report			x	x	x		R	as part of PA-11
PA-	TAS21		Contingency Analysis Report				x	x		R	Deleted for PDR
PA-	TAS22		As Built Configuration List (ABCL)						x	R	as part of EIDP
PA-	TAS23		As Built EQM Components list						x	R	as part of EIDP

12.2 GSE DRL PA DOCUMENTS (25)

MS-PA-REQ-5210

Verification:

Traces:

The following table identified complete set of all PA documentation applicable at Program level. Specifically required PA documents related to each item are listed in the relevant SOW DRL.

Item	Number	DRD Ref	Title	Submittal	Proposal	PDR	MRR/CDR	QR	DRB	Class	Remark
			For GSE contractors the following listed items are applicable.								

Item	Number	DRD Ref	Title	Submittal	Proposal	PDR	MRR/CDR	QR	DRB	Class	Remark
PA-	01		Product Assurance & Safety Plan incl. SW QA		x	x	x			A	Including the Compliance Matrix versus PA Requirements for Subcontractors
PA-	04		Status lists (RFA-NCR (M&m)-SPR-RFD-RFW)	As generated						A	Major for approval; minor for review
PA-	TAS07		Product Assurance Progress Report	as Project PR						R	Part of Project Progress Report; content see PARS
PA-	010		End Item Data Package (EIDP); S/W, GSE						x	AR	Acceptance at FAR
PA-	011		FMECA (functional level & S/C interfaces at part level)			x	x	x		A	
PA-	043		Hazard Analysis			x	x		x	R	
PA-	044		Inputs to Safety Submission			x	x		x	R	To be updated also in support of System Reviews, on request.
PA-	08		Cleanliness & Contamination Control Plan (in PA-01)			x	x			A	as part of PA-01
PA-	TAS014		Configuration Management Plan incl. SW							R	including software Covered by MT-3
PA-	TAS013		Software Coding Standard (SCOS)			x	x	x		R	
PA-	38		SW Criticality analysis			x	x	x		AR	

12.3 Notification / Delivery Time Summary

MS-PA-REQ-5220

Verification:

Traces:

Notification / Delivery Time Summary	
NCR major	Notification within 48 hours after occurrence
MIP/KIP	Notification 10 working days in advance
TRR/TRB	Notification 10 working days in advance (tbc)
Audits	Notification 10 days in advance
EIDP Alert assesement feedback (notification)	Delivery 14 days in advance to DRB Notification 5 working days after receiving the Alert

12.4 Class acronyms

Class	
A	approval
R	review
I	information

END OF DOCUMENT